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Commercial Marine Activity for Deep Sea Ports in the United States

Final Report

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Assessment and Modeling Division
Office of Mobile Sources
U.S. Environmental Protection Agency

Prepared for EPA by
ARCADIS Geraghty & Miller, Inc.

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COMMERCIAL MARINE ACTIVITY FOR DEEP SEA PORTS IN THE UNITED STATES

Final Report

30 June 1999

PREPARED FOR

U.S. Environmental Protection Agency
Assessment & Modeling Division
2000 Traverwood Drive
Ann Arbor, Michigan 48105

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INTRODUCTION TO COMMERCIAL MARINE ACTIVITY

This report is Volume I of a two volume report on commercial marine activity in the United States developed by ARCADIS Geraghty & Miller, Inc., for the U.S. Environmental Protection Agency (EPA), Office of Mobile Sources. This Volume addresses commercial marine activity at selected Deep-Sea Ports (DSPs), and Volume II addresses commercial marine activity at selected inland river and Great Lake ports.

1.1 MARINE INVENTORY BACKGROUND

The purpose of this report is to present a basis for quantifying and qualifying operational characteristics of commercial marine activity at major DSPs in the U.S. This report details work performed under work assignment (WA) 1-05, a continuation of WA 0-06, of Contract 68-C6-0068, begun in fiscal year 1997 by ARCADIS Geraghty & Miller for the EPA. The activity profiles developed herein may be used to quantify emissions from DSPs in the United States. EPA eventually plans to use data derived from these activity profiles as default inputs to EPA's NONROAD model.

As air emission inventories become more precise, it becomes necessary to chronicle all types of activities that could impact air quality. Because marine vessel emissions are believed to be a significant portion of the emission inventory, their operations and emissions must be better understood before the true impact of marine emissions on air quality can be assessed. Marine vessel activities have been investigated in the past, but in general these studies focused on only a few ports or made assumptions about all vessels based on data for only a few ship-types. This report will help EPA to assist state and local air pollution control agencies in forming a more precise picture of commercial marine activity at DSPs, a large contribution to overall marine activity, and may help in devising incentive programs and regulations to reduce emissions from the marine sector.

1.2 DATA SOURCES FOR COMMERCIAL MARINE INVENTORIES

A set of ports were selected for detailed analysis in this report. These ports are referred to as Typical Ports throughout this document. Data on the Typical Ports were available from Marine Exchanges and Port Authorities (MEPAs) associated with each Typical Port. Often, one MEPA would have data on more than one Typical Port. The MEPA Areas shown in Table 1-1 were selected because they contain Typical Ports which are fairly representative of the various types of ports found in the U.S. and because they had data available in electronic format. Three east coast areas, three gulf coast areas, and two west coast areas were selected as MEPA Areas containing Typical Ports. Methodology to extrapolate these Typical Ports activity profiles to other ports in the U.S. that are similar in nature to the Typical Ports has also been developed within this report.

Table 1-1. MEPA Areas containing Typical Deep-Sea Commercial Marine Ports

MEPA Areas	Major Waterways	Ocean Access
Lower Mississippi River Ports - Including New Orleans, Port of Southern Louisiana, Port of Plaquemines, and Port of Baton Rouge, LA	Mississippi River	Gulf of Mexico to the Atlantic
Consolidated Ports of New York and New Jersey - Including Albany and other ports on the Hudson and Elizabeth Rivers	Upper New York Bay, Newark Bay, Hudson River, Arthur Kill River, Kill van Kull River, and East River	Raritan Bay, Lower New York Bay, or Long Island Sound to the Atlantic Ocean
Delaware River Ports - Including Philadelphia, PA, Camden, NJ, Wilmington, DE	Delaware River	Delaware Bay to the Atlantic Ocean
Puget Sound Area Ports - Including Seattle, Tacoma, Olympia, Bellingham, Anacortes, Grays Harbor, WA	Puget Sound	Strait of Juan de Fuca or Strait of Georgia to the Pacific Ocean
Corpus Christi, TX	Nueces Bay and River	Corpus Christi Bay to the Gulf of Mexico
Coos Bay, OR	Coos Bay	Coos Bay to Pacific Ocean
Patapsco River Ports - Including Baltimore Harbor and anchorages at Annapolis, MD	Parts of the Chesapeake Bay, the Patapsco River, and Marley Creek	Chesapeake Bay to the Atlantic Ocean or Chesapeake and Delaware Ship Canal to the Delaware River
Port of Tampa, FL	Tampa Bay	Tampa Bay to the Gulf of Mexico

In addition to the MEPA Areas listed in Table 1-1, a report prepared by Acurex Environmental Corporation (the former name of ARCADIS Geraghty & Miller) for the South Coast Air Quality Management District (SCAQMD) details vessels and activities at the Ports of Los Angeles and Long Beach. The report is titled "Marine Vessel Emissions Inventory and Control Strategies" (Reference 1-1). In addition, ARCADIS Geraghty & Miller developed less detailed activity profiles (cumulative trips and tonnage organized by ship-type) for the Top 95 DSPs in the U.S. The DSP data can then be used for applying Typical Port activity data to other of the DSPs.

Varied data sources were used to collect the data for this report. Four different databases, augmented with information from pilots and other experts, were used to find the data used to characterize the Typical and DSPs. The data sources, and a brief explanation of the data uses, are listed below. For a more detailed discussion of the data, refer to the sections referenced below and also to Appendix A.

- *United States Army Corps of Engineers* - The Waterborne Commerce Statistics Center of the United States Army Corps of Engineers (USACE) provided data used to develop total domestic trips and total domestic tonnages for the DSPs in the U.S. (See Section 2)
- *United States Bureau of Census (Census Bureau)* - Data provided on the Navigation Data Center Publications and U.S. Waterway Data CD by the Census Bureau were used to develop the total foreign trips and tonnages for the DSPs in the U.S. (See Section 2)
- *Marine Exchange/Port Authority (MEPA)* - Data were obtained from these port-specific sources to develop vessel movement data for each Typical Port (See Section 3 and Sections 6 through13).
- *Lloyds Maritime Information Service (LMIS)* - Data were provided from the Lloyds Register on vessel characteristics such as horsepower and engine speed. These data were matched with the vessel data from the MEPAs. (See Section 3)
- *Pilot Data* - Tide books and communications with the pilots were used to estimate distance and speed data within the Typical Ports. These data were used with the MEPA data to develop time-in-modes (See Section 3 and Sections 6 through 13).
- *Port Series Reports* - Reports covering the principal U.S. coastal, Great Lakes, and inland ports are compiled and published by the Ports and Waterways Division, Water Resources Support Center, USACE. The data in these reports were used in conjunction with pilot data to develop the detailed port data in Appendix B.

The relationships between these data sources are shown in Figure 1-1.

The data listed above and shown in Figure 1-1 were used to determine how a ship-type operates in each Typical Port, how many of each ship-type called on the Typical Port in the given year, and the characteristics of the ship-type. These data will be used in with the appropriate emission factors to determine the emissions per ship-type for each mode of operation in the given year. This report provides ship-type categories as well as the values to use for the number of calls per year, the average time-in-mode, and the average rated horsepower. Other factors needed for determining emission inventories, such as the load factors and emission factors, are not discussed in this report.

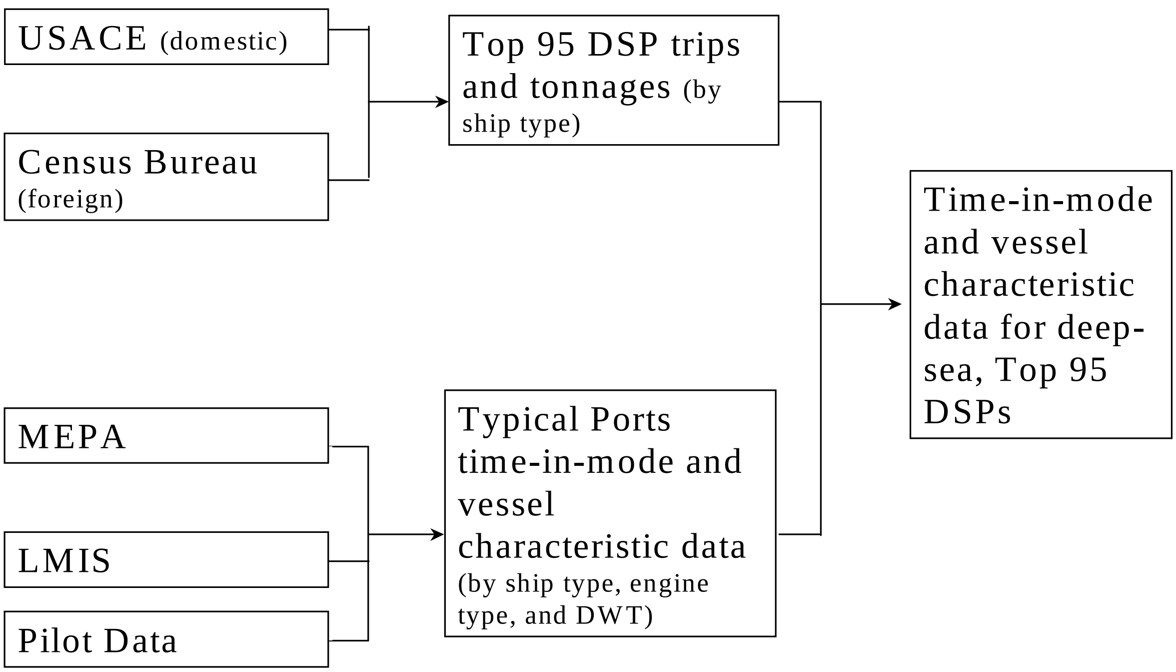


Figure 1-1. Data source relationships for commercial marine inventory

1.3 APPROACH TO COMMERCIAL MARINE INVENTORIES

The calculation of a commercial marine inventory will use a different approach than that used for the other types of nonroad equipment. For other types of nonroad equipment, EPA's NONROAD model starts with a national population and allocates it to the local level using various surrogate data related to a given category or type of equipment, such as census, sales, or licensing and registration data. This type of allocation is not possible for the commercial marine module because there is no reliable population inventory of commercial marine vessels. Vessels built and sold in one area are not necessarily used in that area, and many deep-sea vessels are registered with countries other than the U.S. Marine engines operate over great distances, and are thus often far from their home ports. Although various estimates of commercial marine engine populations exist, the contribution of these engines to air quality will vary based on their operational characteristics. For example, a 2,000-hp diesel marine engine will operate one way on a towboat that frequently changes speed and direction over short trips, and operate in a completely different way on a tanker vessel that may travel hundreds of hours at steady power on each trip. For all of these reasons, it is not possible to develop marine activities and emission profiles based on population estimates alone.

Our approach to the deep-sea component of the commercial marine inventory relies on a detailed analysis of a set of Typical Ports to be used in conjunction with less detailed data on the Top 95 DSPs in the

U.S. This approach provides a clear summary of the major DSPs as well as a more detailed analysis of the Typical Ports. The foundations of this approach are the activity data for the Typical Ports that give information on vessel equipment such as power, speed, and age as well as information on vessel movements. Thus, an air emissions modeler can determine average emissions based on emission characteristics developed from the average modes of operation. In order to develop the activity data, this report does the following:

- Lists the Top 95 DSPs in the U.S. as determined by cargo tonnage for 1995 by the USACE
- Provides an inventory of the number of trips, by vessel type, at the Top 95 DSPs in the U.S. for 1995
- Provides an inventory of the tons of cargo handled, by vessel type, at each of the DSPs in the U.S. for 1995
- Provides Federal Information Processing Standard (FIPS)[1] codes for the DSPs in the U.S. Each county has a unique FIPS code, and the county names are also given for each county within a port
- Provides detailed data, collected from the ports themselves, on vessel movements for eight MEPA Areas containing a total of 25 Typical Deep-Sea Ports for 1996
- Provides vessel characterizations, by vessel type, for the MEPA Areas including such equipment details as propulsion horsepower, vessel speed, and engine age
- For each MEPA Area, provides a vessel category breakdown of each ship-type into deadweight tonnage (DWT) and engine type categories
- Breaks down each vessel category's speeds into four speed ranges, or modes, and provides the time-in-mode for each vessel category
- Provides a methodology for allocating time-in-mode activity data from a Typical Port to a Modeled Port

An activity scenario for each Typical Port is specified in terms of categories of vessels, number of vessels in each category for the given year (1996), and the average number of hours per call for each ship-type category at each of the time-in-modes associated with cruising, reduced speed, maneuvering, and hotelling. The time-in-mode values developed for the Typical Ports were based on actual activity information acquired directly from the MEPAs. The ship characteristics and time-in-mode data can be used to develop default operating time-in-modes for other DSPs based on similarities between a given DSP and a given Typical Port. This will yield a more easily obtained and more accurate estimate of vessel emissions for a wide range of ports than has been available in the past.

To develop a DSP emissions inventory, a modeler will seek out the Typical Port most like the port to be modeled. This port of interest is defined as the Modeled Port in this report. Time-in-mode and vessel

[1]FIPS codes are distinct, unique, numeric identification codes assigned to each county by the U.S. government.

characteristics by ship-type will be available for the Typical Port and the modeler can either use these as the Modeled Port's default values or specify values specific to the Modeled Port, if such data are available. Thus, a state or local agency would have the option of using either locally available time-in-mode characteristics unique to the Modeled Port or to use the default values from a Typical Port that most closely resembles the Modeled Port.

This report is intended for use by EPA in developing activity profiles for deep-sea commercial vessels at U.S. ports. These profiles will then be used with emission factors to develop emission profiles for deep-sea ports. This report can also be used to facilitate data gathering and modeling efforts at the state and local levels by providing an understanding of the data that was gathered and used in this report.

1.4 REPORT ORGANIZATION

Two tasks in WA 1-05 are detailed in this draft report. Task 1 concerned an activity list for the DSPs in the U.S. A list of these ports was compiled under WA 0-06 and is presented in this report by ship-type with the number of trips per port and cargo tonnage per port. Task 2 consisted of finding and documenting data from the MEPAs for large deep-sea ports, typical international ocean ports, and typical domestic ocean ports. This report presents data from eight MEPA Areas, each containing one or more of the DSPs. WA 1-05 also asked for data on the Great Lakes ports and major river ports. Although efforts were made to obtain reliable data for the Great Lakes, the Upper Mississippi River, and the Ohio River, data for these regions proved to be difficult to obtain and those data that were obtained were in formats very dissimilar to the data received for the deep-sea ports. A separate report entitled "Volume II - Activity Profiles at U.S. River and Lake Ports" addresses these waterway regions.

This report is organized into 17 sections. Section 1 is this introduction to the purpose and organization of the report. Section 2 is a presentation of the DSP data, data sources, and methodology for developing the data. Section 3 is a presentation of the Typical Ports used in this study, operations in a Typical Port, and a summary of the data obtained from the LMIS. Section 4 is a discussion of the methodology to be used to allocate MEPA Area data to the DSPs. Section 5 presents data qualifiers for Sections 2, 3, and 4. Sections 6 through 13 each present detailed data on one of the deep-sea MEPA Areas which contain the Typical Ports. Section 14 provides information on the tugboats and pushboats (tugs) currently used at each of the Typical Ports. Section 15 provides information on ferries currently used at each of the Typical Ports. Section 16 provides recommendations for future work. References for each of the sections follows in Section 17. In addition, the following Appendices are included at the end of the report. Appendix A gives descriptions for each field purchased from each MEPA. Appendix B gives detailed port information on each port in this report. Appendix C lists ports contacted, with contact information for each port and the results of the communication.

SECTION 2

TOP 95 DEEP-SEA PORTS

2.1 PURPOSE

The data on the DSPs will be used to:

- Rank the DSPs in the U.S. as determined by 1995 cargo tonnage records
- Provide an inventory of the number of trips, by vessel type, for 1995 at the DSPs in the U.S.
- Provide an inventory of the tons of cargo handled in 1995, by vessel type, at each of the DSPs in the U.S.
- Determine county affiliations and federal county codes for the DSPs in the U.S. (for allocation purposes)
- Allow an estimation of activity at each of the DSPs when coupled with the information presented in Sections 6 through 13 for the Typical Ports.

2.2 DATA SUMMARIZED AND EXPLAINED

Before looking closely at the ship-types and the cargo tonnages, it is necessary to review the language of vessel movements. The terms most commonly used in the USACE data are given and defined in Table 2-1.

Table 2-1. Vessel movements described

Term	Definition and Explanation
Port	A defined area of marine commerce within a navigable body of water. Ports have distinct boundaries but may be nearly 100 miles long in some instances. Port and waterway codes may be identical. They differ when a port is on a waterway that has more than one port on the waterway. For instance, the Port of New Orleans has port/waterway code 2251 and is located on port/waterway code 6032, Mississippi River, New Orleans to Mouth of Passes.
Waterway	A navigable body of water that may or may not have a port within it. Waterway codes and port codes are identical for some bodies of water.
Entrance	When a vessel enters a port/waterway area. An entrance is recorded for a vessel entering the waterway and is analogous to one trip.
Clearance	When a vessel leaves a port/waterway area. A clearance is recorded for a vessel exiting the waterway and is analogous to one trip.
Trip	A trip is one entrance *or* one clearance from a USACE recognized port/waterway. A trip is a one-way movement. Trips may also occur *within* a port/waterway. Trips within a port are considered intraport and may be analogous to MEPA Area shifts (see Section 3.5).
Intraport	Intraport movements are trips within the boundaries of one port. MEPAs treat intraport movements as shifts and may or may not record these activities. Trips and tonnages associated with intraport trips are not included in the DSP summary tables as the summary data are to be used with calls rather than shifts.

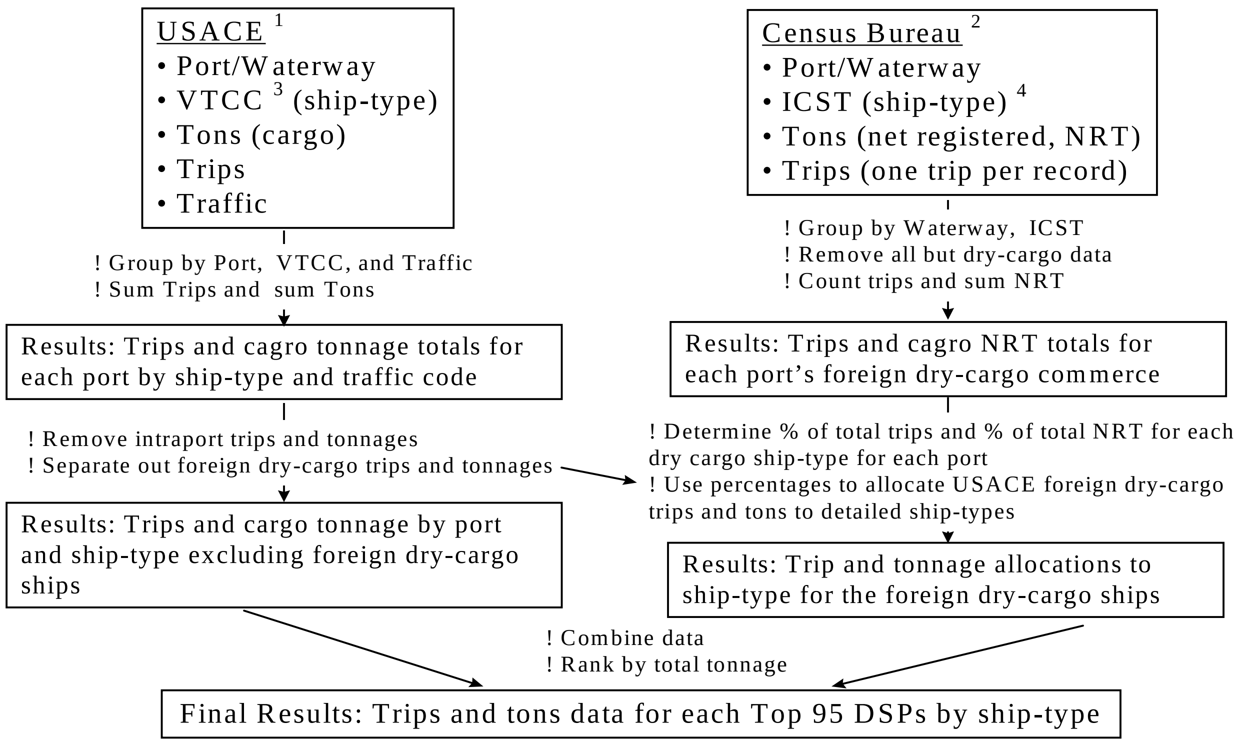
In some instances, the terms port and waterway can be used nearly interchangeably. In most cases, traffic recorded for the waterways is generally much less than that recorded for the nearby ports. For example, the Lake Washington Ship Canal is the only commercial entrance to Lake Washington and is accessed through the Seattle Harbor. USACE records a total of 6,626 trips for Seattle Harbor and only 95 trips for the Lake Washington Ship Canal. Thus, the inclusion or exclusion of waterway trips and tonnages to the nearby port trips and tonnages often appears insignificant to the overall data for the port. In general, waterways were included as part of the nearby ports in this report.

There are different types of ships involved with the transportation of cargo, and each ship-type has unique characteristics that affect emissions. Ship-types generally relate to the type of cargo a vessel carries. While the type of cargo is not directly interesting from an emissions standpoint, different ship-types have different operating characteristics. Not all records are explicit about the type of vessel. There are general groupings of (1) dry-cargo-self propelled, (2) liquid cargo-self propelled, (3) tugboat/towboat, (4) dry-cargo, non self-propelled, (5) liquid cargo, non self-propelled, and (6) other. Within these general categories, all of the domestic ships in the USACE data had a further breakdown to indicate, for instance, that the dry-cargo-self-propelled vessel in the record was a bulk carrier or container ship. Since many ports have a significant amount of non-domestic travel, another data source was needed to provide records on foreign vessels by ship-type. Data were available from the Census Bureau that provided ship-types for many of the foreign ships.

The data presented in this section were collected by the USACE and the Census Bureau. Data on domestic flag vessels were received from USACE and data on foreign flag vessels from the Census Bureau. Data received included trips and cargo tonnages for each port/waterway area in the U.S. recognized by the USACE. This trip and cargo data can be used separately or together to estimate ship traffic and activities in order to estimate emissions due to commercial marine vessel activity from port areas.

Figure 2-1 graphically presents the primary databases and the actions taken to produce the DSP data summaries. In order to determine the trips and tonnages for the foreign self-propelled dry-cargo vessels, the Census Bureau data were used in conjunction with the USACE data. While the USACE data includes foreign vessels, it does not include detailed ship-types for foreign vessels. The USACE data identifies these foreign ships simply by the general groupings given above. The Census Bureau data, however, did include detailed ship-type descriptions for many of the foreign vessels.

The trips and tonnages given by the Census Bureau were similar but different from those given in the USACE data. In order to present a cohesive data summary, the USACE data were used. For dry-cargo ship-types USACE first had to be allocated based on ratios developed using the Census Bureau data. Dry-cargo vessels include bulk carrier, container ships, general cargo, passenger, reefer, RORO, and vehicle carrier ship-types. Ratios of dry-cargo trips and tons were developed using the Census Bureau data for each port.



[1] Source data: United States Army Corps of Engineers Waterborne Commerce Statistics Center
[2] Source data: United States Bureau of Census data published on the "NDC Publications and U.S. Waterway Data CD" 1996
[3] VTCC = Vessel Type Construction and Characteristics, [4] ICST = International Ship Type Classification
! Actions performed on the data are denoted by "!"

Tons of cargo is another way of determining the importance of a ship-type or a port, as more cargo indicates either more vessel trips or vessels with heavier loadings, both of which are precursors to more emissions. Thus, both trips and tons of cargo are presented in the summary tables in Section 2.3.

Ship-types and descriptions are presented in Table 2-2. The ship-types given are those included in the summary tables, Tables 2-4 and 2-5. Neither Table 2-3 nor Tables 2-4, 2-5, or 2-6 present intraport trips or tons (i.e. for a vessel movement within the same port). Tables 2-4 and 2-5 present the DSPs ranked in order of net cargo tonnage recorded as sent/received by the port. Only the Top 95 DSPs as determined by the data from the USACE are included in this table. Heavily traveled inland river and Great Lake's ports are included in Volume II of this report. All of the DSPs will use the data and methodologies discussed herein and in Section 4. Table 2-4 presents the total number of trips per ship-type, and Table 2-5 presents the tons of cargo by ship-type. Table 2-6 presents summary totals for foreign, domestic, and total tons of the DSPs, along with FIPS codes and corresponding county names for each of the DSPs.

Table 2-2. Ship-type descriptions

Ship-Type	Description
Barge Carrier	Self-propelled vessel that tows lash-barges (barges that are lashed together).
Bulk Carrier	Self-propelled dry-cargo ship that carries loose cargo, such as grain or stone.
Container Ship	Self-propelled dry-cargo vessel that carries containerized cargo. Containers are usually of a standard size and are loaded and unloaded with cranes, making the loading and unloading of this type of vessel relatively quick.
Cruise	Passenger ships designated as entertainment vessels (generally travel longer distances than Excursion, Ferry, or Passenger).
Dry-cargo Barge	Non self-propelled combination category of all non self-propelled barges that carry dry-cargo including lash, open, covered, and deck barges.
Excursion	Passenger vessels that are used mainly for short-duration entertainment trips.
Ferry	Ferries or passenger/roll-on/roll-off combinations used to move people and/or automobiles.
General Cargo	Self-propelled cargo vessels that carry a variety of dry-cargo. May be loose or bagged.
Liquid Cargo Barge	Non self-propelled combination category of all barges that carry liquid cargo, including single hull, double hull, chemical tanker, and petroleum barges.
Other	Category for those vessels that do not fit into one of the other categories or are of a type unknown by the USACE.
Passenger	Self-propelled dry-cargo passenger or combination passenger/cargo vessels that carry passengers but are not designated as cruise ships.
Reefer	Self-propelled refrigerated dry-cargo vessel that often carries meat, fish, or other perishable items.
Roll-on/Roll-off (RORO)	Self-propelled vessel that handles cargo that is rolled on and off. RORO cargo includes automobiles and wheeled containers.
Specialized Carrier	A specialized self-propelled dry-cargo vessel. Treated as an Unspecified Dry-Cargo vessel in other sections of this report.
Supply Vessel	Self-propelled vessel combining supply vessel and support vessel categories, examples of which are supply vessels for off-shore oil rigs.
Tanker	Self-propelled liquid cargo vessels including chemical tankers, petroleum products tankers, LPG carriers, and liquid foodstuff carriers.
Tug	Towboats and pushboats used to escort and give docking assistance to deep sea vessels as well as to move barges.
Unspecified Dry-Cargo	General category for the foreign self-propelled dry-cargo ships that did not have detailed ICST codes included in the Census Bureau database.
Vehicle Carrier	Self-propelled dry-cargo vessel that carries containerized automobiles.

Table 2-3. USACE trip and ton totals and relative ranks by ship-type for the DSPs

USACE Ship-Type	Trips	Trip Rank	Tonnage	Ton Rank
BA	250	15	1,540,754	14
BC	21,325	8	13,109,415	10
BD	262,606	2	115,126,620	5
BL	207,370	3	319,334	15
CS	25,445	7	5,781,089	12
GC	9,798	10	19,345,885	8
OT	2,854	14	239,710,436	4
PA	12,336	9	6,306,968	11
RF	3,901	13	268,338,652	3
RO	7,965	11	104,656,006	6
SV	51,993	4	656,076,633	1
TA	38,535	5	1,674,588	13
TUG	303,202	1	15,238,053	9
UC	37,858	6	29,886,379	7
VC	3,957	12	343,915,908	2
Total	989,396	NA	1,821,026,720	NA

Ship-types are abbreviated in Tables 2-3, 2-4, 2-5, and 2-7 as follows:

BA = Barge Carrier

BC = Bulk Cargo Carrier

BD = Dry-cargo Barge

BL = Liquid Cargo (Tanker) Barge

CS = Container Ship

GC = General Cargo

OT = Other, Unknown, or Undefined

PA = Passenger, Cruise and Excursion

RF = Reefer

RO = RORO and Ferry

SV = Supply Vessel and Support Vessel

TA = Tanker

TUG = Tugboat and Pushboat

UC = Unidentified Dry-cargo

VC = Vehicle Carrier

2.3 DATA ORIGINS AND DETAILS

The number of vessels for each DSP were determined from two databases. One database, from the USACE Waterborne Commerce Statistics Center, records the port code, type of vessel, tons of cargo, number of trips per vessel type, and month of trip for domestic vessels. Port codes and waterway codes are assigned by USACE to all navigable waters in the U.S. As stated in Table 2-1, the port code is more specific and refers directly to a port or harbor area. The waterway code usually refers to a more general waterway area that often contains port or harbor areas. Knowledge of vessel type is important because there are distinct differences between operating characteristics and, therefore, between emissions of various types of deep-sea vessels.

Included in the USACE files are data on foreign vessels. While USACE receives this data from the Census Bureau, they do not have permission to provide some details of foreign vessel traffic. USACE may only release the number of foreign entrances and clearances by a general ship-type description. Another shortcoming of these foreign data is that the foreign trips are not recorded in the USACE database by month. Foreign shipments for the year are included in January totals, and foreign receipts for the year are included in December. Therefore, another data source is needed in order to obtain detailed ship-type descriptions and monthly breakdowns of foreign vessel traffic.

To obtain more detailed ship-type descriptions and monthly breakdowns for foreign vessel traffic, we used data available on the "U.S. Waterway Data CD-ROM" made available by the Census Bureau's Bureau of Transportation Statistics (Reference 3-2). The fields available in this database include vessel name, month in which the data were recorded, port/waterway entered or cleared, international classification by ship-type (ICST) code, flag of registering country, waterway schedule to indicate the next or last port visited, net registered tons, and draft. The data on the CD-ROM are gathered from the Census Bureau who collects the data from U.S. Customs entrance clearance forms.

Both the foreign and domestic vessel files had port/waterway codes to define what port was being entered or cleared. There is a master list of waterways recognized by the USACE on the Waterway CD-ROM. This list was used to query the foreign and domestic databases and to break the data down into the DSPs. The DSPs were ranked by the most cargo tonnage (combination of shipments and receipts) for the calendar year 1995. Table 2-7 presents the corresponding VTCC (domestic) and ICST (foreign) ship-type codes and descriptions. The match between the VTCC and ICST codes comes from the USACE CD-ROM from the Waterborne Transportation Lines of the United States (WTLUS).

Table 2-4. Top 95 Deep-Sea Ports, trips by ship-type for 1995

Rank	Port Name	BA	BC	BD	BL	CS	GC	OT	PA	RF	RO	SV	TA	TUG	UC	VC	Grand Total
1	Port of South Louisiana, LA	-	2,713	76,063	21,064	10	163	-	40	10	26	4	1,645	19,114	604	-	**121,457**
2	Houston, TX	5	1,174	5,183	31,519	884	506	52	186	111	355	572	4,482	16,704	2,350	68	**64,152**
3	Port of New York	25	453	6,488	6,686	3,202	722	2	243	108	611	9	3,218	9,608	1,523	407	**33,306**
4	Port of Baton Rouge, LA	-	1,171	23,855	18,241	33	194	-	33	-	3	15	1,079	12,157	325	-	**57,106**
5	Valdez Harbor, AK	-	-	111	48	-	-	-	29	-	-	-	1,270	195	-	-	**1,653**
6	Port of New Orleans, LA	70	2,134	27,111	12,884	853	352	16	144	23	252	111	891	19,258	1,702	-	**65,800**
7	Port of Plaquemine, LA	-	675	31,011	5,997	3	22	5	28	-	-	3,280	1,035	8,298	144	-	**50,498**
8	Corpus Christi, TX	2	407	1,030	7,590	7	27	-	125	-	10	2,702	1,921	4,716	98	-	**18,634**
9	Long Beach Harbor, CA	-	695	91	1,285	1,848	90	13	503	75	118	3,858	1,091	7,587	669	74	**17,997**
10	Mobile Harbor, AL	-	618	20,915	3,677	44	317	21	194	4	209	1,959	211	5,506	690	2	**34,368**
11	Tampa Harbor, FL	-	958	1,134	1,312	32	229	17	96	238	64	-	974	2,369	534	2	**7,959**
12	Texas City, TX	-	41	469	11,552	4	12	2	7	5	-	53	740	8,214	19	-	**21,118**
13	Port Arthur, TX	-	321	1,398	4,202	24	126	20	10	2	16	95	1,220	5,430	189	-	**13,054**
14	Los Angeles Harbor, CA	-	370	3,132	1,586	2,063	108	15	660	372	279	1,426	1,001	8,389	708	300	**20,411**
15	Lake Charles, LA	2	236	3,094	10,375	38	342	7	2,686	38	51	14,177	874	6,876	223	2	**39,021**
16	Baltimore Harbor, MD	-	806	3,200	1,285	966	208	42	32	4	507	-	309	3,480	1,097	398	**12,334**
17	Philadelphia, PA	-	164	216	2,711	230	84	-	25	87	102	-	972	11,314	274	31	**16,210**
18	Marcus Hook, PA	-	17	21	3,039	1	106	-	8	-	2	-	641	5,544	7	-	**9,386**
19	Port of Portland, OR	1	614	8,884	4,127	478	61	-	701	9	111	-	299	10,016	286	219	**25,805**
20	Pascagoula Harbor, MS	-	157	1,118	3,639	8	30	22	69	20	49	877	577	2,426	376	-	**9,367**
21	Seattle Harbor, WA	41	278	4,463	1,929	1,484	255	19	60	49	213	4	209	9,448	535	44	**19,030**
22	Paulsboro, NJ	-	5	285	3,434	-	49	-	2	2	-	-	630	6,845	-	-	**11,251**
23	Port of Newport News, VA	15	521	937	269	137	101	2	17	2	65	-	220	7,794	293	25	**10,398**
24	Beaumont, TX	-	78	1,846	7,837	6	13	-	2	2	24	357	719	7,268	49	-	**18,200**
25	Richmond Harbor, CA	-	82	33	1,201	16	27	2	-	-	32	-	838	520	108	62	**2,921**
26	Tacoma Harbor, WA	-	432	1,521	1,400	610	15	2	-	4	379	-	282	5,115	270	111	**10,140**
27	Freeport, TX	-	71	254	4,423	72	47	3	1,541	3	13	2,746	788	2,195	115	-	**12,271**
28	Port Everglades Harbor, FL	-	148	155	459	1,390	557	910	830	74	437	-	733	730	3,962	-	**10,385**
29	Savannah Harbor, GA	46	473	405	373	1,051	384	2	8	68	354	-	456	937	1,024	-	**5,580**
30	San Juan Harbor, PR	-	145	1,314	523	1,280	206	174	1,005	541	456	-	255	2,144	2,500	187	**10,731**
31	Jacksonville Harbor, FL	2	227	1,034	1,437	769	128	13	-	20	329	-	439	2,086	698	354	**7,536**
32	Port of Boston, MA	-	103	475	951	320	2	6	57	25	9	-	620	1,030	120	28	**3,746**
33	Oakland Harbor, CA	-	106	456	668	2,595	63	9	1	-	38	-	3	1,271	489	81	**5,780**
34	Anacortes Harbor, WA	-	24	89	751	-	-	-	4	-	2	-	394	3,209	91	683	**5,247**
35	New Castle Area, DE	-	-	20	683	4	24	-	4	-	-	-	181	1,633	2	-	**2,551**
36	Norfolk Harbor, VA	-	48	6,736	3,544	21	460	21	-	-	-	3	1,952	12,575	-	-	**25,360**
37	Portland Harbor, ME	-	39	162	416	2	-	15	15	2	41	-	412	765	59	-	**1,928**
38	Honolulu Harbor, Oahu, HI	2	44	4,693	495	400	23	126	47	12	101	108	133	4,025	947	210	**11,367**
39	Port of Kalama, WA	-	315	175	181	-	1	-	-	-	-	-	20	2,998	63	-	**3,753**
40	Charleston Harbor, SC	-	128	34	229	838	127	1	28	16	210	-	362	506	571	103	**3,152**
41	Galveston, TX	1	248	343	2,995	43	167	50	580	80	24	5,594	411	4,135	108	7	**14,785**
42	Matagorda Ship Channel, TX	-	205	1,435	1,412	2	34	1	-	-	-	6	173	1,265	51	-	**4,584**
43	New Haven Harbor, CT	-	155	219	1,325	-	28	6	-	-	2	4	323	1,645	70	-	**3,777**
44	Barbers Point, HI	2	26	93	390	-	-	-	1	-	-	16	241	1,664	19	-	**2,452**
45	Port of Wilmington, NC	6	135	2,494	1,312	332	83	51	4	19	46	-	476	2,393	279	-	**7,630**
46	Port of Vancouver, WA	1	335	784	664	5	83	-	15	-	5	-	28	6,608	151	10	**8,689**
47	Providence, RI	-	81	98	654	2	14	-	-	-	142	-	339	1,187	26	5	**2,548**
48	Miami Harbor, FL	-	46	288	555	2,113	774	346	970	471	691	2	73	928	6,334	124	**13,715**

Table 2-4. Top 95 Deep-Sea Ports, trips by ship-type for 1995 (continued)

Rank	Port Name	BA	BC	BD	BL	CS	GC	OT	PA	RF	RO	SV	TA	TUG	UC	VC	Grand Total
49	Port of Longview, WA	-	427	804	499	-	34	-	4	10	12	-	9	4,295	133	-	**6,227**
50	Port of Albany, NY	-	97	-	938	5	16	-	1	-	8	-	175	974	55	-	**2,269**
51	Camden, NJ	-	269	533	1,540	11	66	-	-	197	18	-	177	6,496	162	-	**9,469**
52	Nikishka, AK	-	2	37	51	-	4	-	-	-	-	-	208	123	-	-	**425**
53	Morehead City Harbor, NC	15	70	344	1,025	6	43	5	-	15	94	306	149	1,041	65	-	**3,179**
54	Wilmington Harbor, DE	-	104	67	415	163	65	-	-	174	42	-	26	609	90	113	**1,868**
55	Everett Harbor, WA	-	113	524	137	-	-	7	-	10	5	260	-	2,107	21	-	**3,184**
56	Coos Bay, OR	-	143	97	92	-	60	-	-	17	147	-	256	373	110	-	**1,295**
57	Bridgeport Harbor, CT	-	-	794	480	-	4	2	-	118	-	7	10	1,214	3	-	**2,632**
58	Fall River Harbor, MA	-	115	47	99	1	4	-	-	2	7	-	24	444	27	-	**770**
59	Anchorage, AK	2	13	95	58	176	5	-	15	-	235	-	66	142	6	-	**813**
60	Palm Beach Harbor, FL	-	103	164	115	-	9	306	5	-	340	-	16	267	2,207	-	**3,532**
61	Panama City Harbor, FL	-	41	1,876	859	8	55	4	32	-	34	-	8	710	199	-	**3,826**
62	Canaveral Harbor, FL	-	193	131	421	5	50	28	144	349	103	-	78	546	308	-	**2,357**
63	Brownsville, TX	-	120	330	507	30	25	8	2	-	6	6	88	509	617	2	**2,250**
64	Kahului Harbor, Maui, HI	-	27	1,364	161	-	2	3	4	1	2	-	-	882	16	-	**2,461**
65	Portsmouth Harbor, NH	-	1	20	118	-	-	18	-	-	-	-	137	97	-	-	**391**
66	Gulfport Harbor, MS	-	36	132	2	202	39	38	-	20	134	52	-	272	94	-	**1,021**
67	Port Jefferson Harbor, NY	-	-	677	304	-	-	-	-	-	-	50	3	863	-	-	**1,897**
68	Brunswick Harbor, GA	-	83	-	356	8	124	-	-	4	53	-	-	313	215	105	**1,262**
69	Ketchikan Harbor, AK	-	43	1,640	182	154	163	20	549	-	-	2	25	1,701	723	-	**5,202**
70	Port Angeles Harbor, WA	11	52	460	278	-	2	22	-	7	16	-	66	1,703	31	-	**2,648**
71	Pensacola Harbor, FL	-	30	356	873	14	16	-	-	-	8	-	9	688	131	-	**2,126**
72	Grays Harbor, WA	-	159	38	6	-	20	-	6	2	-	-	-	210	48	-	**489**
73	Chester, PA	-	17	8	158	61	26	-	-	69	18	-	10	282	246	-	**895**
74	Hilo Harbor, H.I.	-	5	775	163	-	2	59	34	-	6	-	-	584	15	-	**1,643**
75	San Diego Harbor, CA	-	70	43	13	6	414	218	36	37	58	1	33	96	530	71	**1,626**
76	San Francisco Harbor, CA	-	34	188	166	120	8	16	170	-	62	-	91	874	36	24	**1,790**
77	Stockton, CA	-	58	1	48	2	14	-	-	-	-	-	59	44	17	-	**243**
78	Bellingham Harbor, WA	1	24	210	86	13	46	11	8	14	13	-	49	1,561	394	6	**2,435**
79	Searsport Harbor, ME	-	33	15	76	3	25	-	-	-	5	-	81	287	18	-	**542**
80	Bucksport Harbor, ME	-	2	1	99	-	-	-	-	-	-	-	43	152	-	-	**297**
81	Georgetown Harbor, SC	-	98	43	18	-	30	-	-	-	-	-	-	282	59	-	**530**
82	Humboldt Harbor and Bay, CA	-	18	88	144	-	66	-	2	-	18	-	419	181	20	-	**956**
83	Olympia Harbor, WA	-	7	161	6	-	-	4	2	-	-	-	-	550	3	1	**734**
84	Salem Harbor, MA	-	36	-	65	-	-	23	-	-	-	-	8	11	2	-	**145**
85	Port of Richmond, VA	-	20	142	146	16	816	-	-	8	43	-	2	288	127	-	**1,608**
86	Sacramento, CA	-	50	15	2	2	22	-	-	-	18	-	19	14	27	-	**169**
87	Ponce Harbor, PR	-	22	28	-	205	41	57	32	17	2	-	11	37	101	-	**553**
88	Nawiliwili Harbor, Kauai, HI	-	16	742	39	-	-	-	23	-	-	-	-	429	7	-	**1,256**
89	Port Hueneme, CA	-	15	1	35	12	7	10	28	333	75	4,495	-	56	126	99	**5,292**
90	Port of Astoria, OR	-	293	185	250	-	4	1	7	-	3	-	-	1,133	109	-	**1,985**
91	Trenton Harbor, NJ	-	-	216	132	-	-	-	-	-	-	-	-	463	-	-	**811**
92	Port of Hopewell, VA	-	46	167	229	2	31	-	-	-	1	-	8	291	12	-	**787**
93	Weedon Island, Fl	-	-	-	112	-	-	-	-	-	-	-	-	76	-	-	**188**
94	Kawaihae Harbor, HI	-	-	919	14	-	-	-	-	-	-	-	-	472	-	-	**1,405**
95	Orange, TX	-	-	219	711	-	-	1	8	-	-	1	-	1,138	-	-	**2,078**
Grand Total		**250**	**21,325**	**260,062**	**205,557**	**25,445**	**9,724**	**2,854**	**12,124**	**3,901**	**7,965**	**43,158**	**38,523**	**296,000**	**37,858**	**3,957**	**968,704**

Table 2-5. Top 95 Deep-Sea Ports, tonnage by ship-type for 1995

Rank	Port Name	BA	BC	BD	BL	CS	GC	OT	PA	RF	RO	SV	TA	TUG	UC	VC	Grand Total
1	Port of South Louisiana, LA	-	56,108,286	69,843,946	31,278,099	40,808	693,083	-	-	83,737	365,801	-	31,751,235	1,962	11,081,425	-	**201,248,382**
2	Houston, TX	2,146	8,037,822	5,246,926	37,721,583	4,642,510	1,411,127	46,806	302	207,703	1,414,045	4,140	55,832,552	13,914	7,781,661	492,568	**122,855,806**
3	Port of New York	135,483	1,598,013	5,635,245	30,104,016	10,953,317	476,201	-	1,422,566	131,245	2,094,697	-	38,444,923	179	5,711,511	1,225,876	**97,933,273**
4	Port of Baton Rouge, LA	-	16,495,082	21,180,061	20,912,488	127,910	905,123	-	-	-	29,231	-	17,376,110	-	4,020,253	-	**81,046,257**
5	Valdez Harbor, AK	-	-	104,699	180,962	-	-	-	74	-	-	-	80,659,750	-	-	-	**80,945,485**
6	Port of New Orleans, LA	458,105	14,513,393	19,721,239	15,289,257	2,400,868	753,809	64,540	534,457	25,522	935,643	12,430	12,932,031	400	7,550,526	-	**75,192,220**
7	Port of Plaquemine, LA	-	15,284,135	36,271,015	6,660,335	20,297	79,739	2	4	-	-	282	11,294,745	5,741	3,247,950	-	**72,864,244**
8	Corpus Christi, TX	41,199	7,392,820	308,579	13,613,113	13,968	39,274	-	33,161	-	77,757	3,912	45,497,977	236	901,418	-	**67,923,413**
9	Long Beach Harbor, CA	-	4,671,118	169,325	1,514,942	16,711,552	471,287	-	86,395	216,292	528,562	4,504	23,570,064	24	4,635,110	506,015	**53,085,189**
10	Mobile Harbor, AL	-	11,919,617	18,989,257	5,053,396	224,341	1,999,238	113	139,376	18,399	2,542,165	31,754	2,984,336	-	6,022,029	15,598	**49,939,620**
11	Tampa Harbor, FL	-	10,623,568	14,167,146	9,086,159	163,000	652,805	58,968	1,082,859	814,764	292,236	-	11,599,324	55,309	3,191,005	8,274	**51,795,416**
12	Texas City, TX	-	721,665	822,480	15,482,950	19,421	38,572	-	-	23,471	-	1,486	32,613,004	-	216,986	-	**49,940,034**
13	Port Arthur, TX	-	4,044,354	1,257,645	4,828,270	142,703	685,123	56	31,968	6,215	113,531	1,710	36,964,294	22,332	1,531,120	-	**49,629,321**
14	Los Angeles Harbor, CA	-	2,432,618	2,500,867	3,891,566	13,279,754	579,630	632	1,208,227	910,072	1,375,948	6,839	13,902,182	-	4,230,052	1,544,465	**45,862,851**
15	Lake Charles, LA	3,766	2,846,820	2,936,177	12,033,780	230,118	232,595	-	115,203	247,809	407,829	1,038,385	24,688,340	2,031	958,368	11,935	**45,753,157**
16	Baltimore Harbor, MD	-	9,240,381	7,691,103	2,770,522	6,284,412	651,540	375	318,500	5,474	4,178,762	-	1,842,049	255	7,394,372	2,853,302	**43,231,047**
17	Philadelphia, PA	-	1,783,327	107,432	10,227,475	1,183,691	254,017	-	147,070	201,919	417,471	-	23,678,297	-	1,369,761	154,099	**39,524,559**
18	Marcus Hook, PA	-	288,610	41	13,525,689	-	16,877	-	8	-	33,387	-	16,695,736	-	53,174	-	**30,613,522**
19	Port of Portland, OR	-	4,418,655	5,612,973	5,161,426	5,759,500	434,878	11,858	221,719	8,099	1,178,248	-	2,986,413	1,772	2,211,982	2,145,199	**30,152,722**
20	Pascagoula Harbor, MS	-	2,256,751	725,692	6,549,402	85,153	223,074	41,316	396	43,820	188,576	66,479	15,930,231	11,089	798,422	-	**26,920,401**
21	Seattle Harbor, WA	98,377	2,339,298	6,050,703	1,671,982	10,146,993	800,141	181,564	176,128	99,038	399,086	2,770	271,687	70,184	2,829,929	281,676	**25,419,556**
22	Paulsboro, NJ	-	28,256	145,405	10,878,327	-	253	-	-	1,319	-	-	13,452,605	-	-	-	**24,506,165**
23	Port of Newport News, VA	245,567	11,924,597	4,297,842	323,386	902,710	208,503	-	204,571	-	683,963	-	1,146,323	50	3,191,260	236,233	**23,365,005**
24	Beaumont, TX	-	957,352	1,696,650	10,237,912	11,513	96,635	-	-	6,429	271,790	57	6,656,788	-	408,259	-	**20,343,384**
25	Richmond Harbor, CA	-	501,932	20,165	1,754,627	50,450	130,560	-	-	-	159,298	-	17,192,649	-	387,645	335,977	**20,533,302**
26	Tacoma Harbor, WA	-	4,155,995	1,255,497	1,690,431	3,803,267	82,713	1,147,520	-	4,802	2,149,857	-	1,700,178	10,667	3,540,551	920,738	**20,462,215**
27	Freeport, TX	-	864,966	278,658	4,377,828	213,550	211,193	-	16,242	4,785	68,149	161,784	12,944,539	20	327,917	-	**19,469,631**
28	Port Everglades Harbor, FL	-	196,636	199,452	2,507,286	1,050,290	297,030	43,501	2,192,843	13,842	227,572	-	10,644,122	7	994,808	-	**18,367,389**
29	Savannah Harbor, GA	210,669	1,613,040	826,083	1,069,321	4,906,299	954,506	-	23,113	92,397	1,417,738	-	3,728,049	-	2,363,100	-	**17,204,315**
30	San Juan Harbor, PR	-	116,094	3,148,926	2,307,377	327,163	41,235	467	1,210,381	128,307	128,573	-	4,024,893	1,131	3,921,843	96,754	**15,453,146**
31	Jacksonville Harbor, FL	5,543	535,537	1,669,040	2,007,426	1,185,428	181,729	13	-	14,707	1,148,413	-	5,324,370	22,161	2,291,938	952,158	**15,338,462**
32	Port of Boston, MA	-	294,954	1,174,490	4,643,501	998,086	1,311	-	239,636	8,264	17,591	-	7,629,838	155	234,194	79,274	**15,321,293**
33	Oakland Harbor, CA	-	225,116	427,506	770,482	8,816,981	155,903	-	-	-	137,354	-	109,239	-	2,203,321	378,216	**13,224,118**
34	Anacortes Harbor, WA	-	205,839	266,030	1,534,800	-	4,647	163,800	-	-	253	-	10,683,912	89,143	130,843	2,103	**13,081,370**
35	New Castle Area, DE	-	-	6,845	4,780,276	4,099	120	-	3	-	-	-	7,663,045	-	1,421	-	**12,455,809**
36	Norfolk Harbor, VA	-	1,094,654	5,879,343	3,175,058	-	41	-	-	-	-	-	1,584,520	74	68,916	-	**11,802,606**
37	Portland Harbor, ME	-	305,403	294,581	1,498,470	5,063	-	-	75,500	2,112	57,951	-	9,131,950	-	93,192	-	**11,464,222**
38	Honolulu Harbor, Oahu, HI	134	62,570	5,176,416	683,549	1,407,347	16,253	10	57,334	6,703	285,340	-	1,864,593	360	1,006,950	870,835	**11,438,393**
39	Port of Kalama, WA	-	8,809,972	334,279	285,574	-	-	-	-	-	-	-	56,428	-	1,860,293	-	**11,346,546**
40	Charleston Harbor, SC	-	395,962	1,502	778,807	3,033,527	372,336	-	104,904	14,998	695,069	-	3,677,764	137	1,681,927	385,621	**11,142,555**
41	Galveston, TX	32,305	2,815,897	336,718	1,789,619	378,204	84,405	728	65,027	284,249	276,736	166,402	3,448,354	-	663,028	98,828	**10,440,500**
42	Matagorda Ship Channel, TX	-	4,429,391	1,145,620	1,464,764	12,943	68,701	-	-	-	-	-	1,220,039	-	853,072	-	**9,194,530**
43	New Haven Harbor, CT	-	657,444	434,887	5,169,804	-	80,570	-	-	-	1,366	-	2,213,492	1,218	195,617	-	**8,754,399**
44	Barbers Point, HI	1,946	547,307	69,098	743,412	-	-	-	-	-	-	-	6,629,209	-	232,890	-	**8,223,862**
45	Port of Wilmington, NC	30,779	334,265	17,399	2,002,309	1,173,353	206,453	1,293	16,265	20,515	185,695	-	3,315,543	1	525,318	-	**7,829,188**
46	Port of Vancouver, WA	1,202	2,984,184	1,280,072	891,554	86,825	716,920	2,465	-	-	60,855	-	84,128	-	1,306,803	115,556	**7,530,564**
47	Providence, RI	-	430,864	262,187	3,552,886	3,608	72,830	-	-	-	18,969	-	2,353,810	-	135,919	51,829	**6,882,902**
48	Miami Harbor, FL	-	26,763	133,262	710,364	1,430,934	139,808	1,425	1,791,183	200,565	242,086	-	571,851	1,041	1,255,050	74,146	**6,578,478**
49	Port of Longview, WA	-	3,274,431	773,750	398,462	-	350,230	4,977	14,277	49,955	105,102	-	57,414	-	1,133,237	-	**6,161,835**

Table 2-5. Top 95 Deep-Sea Ports, tonnage by ship-type for 1995 (continued)

Rank	Port Name	BA	BC	BD	BL	CS	GC	OT	PA	RF	RO	SV	TA	TUG	UC	VC	Grand Total
50	Port of Albany, NY	-	821,727	-	4,028,576	22,048	47,121	-	-	-	43,310	-	463,728	-	356,829	-	**5,783,340**
51	Camden, NJ	-	1,430,501	727,185	1,606,399	33,996	133,330	-	-	465,540	28,044	-	760,114	5	541,310	-	**5,726,424**
52	Nikishka, AK	-	5,903	233,984	219,563	-	24	-	-	-	-	-	4,240,236	-	-	-	**4,699,710**
53	Morehead City Harbor, NC	239,776	655,345	339,980	1,103,874	24,379	81,528	4,355	-	25,793	409,186	26	1,258,172	-	434,828	-	**4,577,242**
54	Wilmington Harbor, DE	-	534,629	95,103	640,554	538,329	204,678	-	-	305,189	288,011	-	715,985	-	330,196	608,840	**4,261,514**
55	Everett Harbor, WA	-	973,785	551,764	53,770	-	1,292	2,172,486	-	31,510	13,430	2,980	-	-	100,035	-	**3,901,052**
56	Coos Bay, OR	-	873,062	47,600	75,106	-	413,376	-	-	31,297	1,453,442	-	-	-	715,979	-	**3,609,862**
57	Bridgeport Harbor, CT	-	-	1,290,241	1,704,774	-	1,733	-	-	322,679	-	-	121,393	-	3,068	-	**3,443,888**
58	Fall River Harbor, MA	-	2,117,607	367,115	560,684	3,591	17,895	-	-	1,847	24,339	-	15,158	-	171,752	-	**3,279,988**
59	Anchorage, AK	4,682	107,752	138,020	246,239	-	49	-	85,746	-	786,964	-	1,091,649	924	759,464	-	**3,221,490**
60	Palm Beach Harbor, FL	-	185,828	1,078,388	1,075,052	-	2,524	282	-	-	163,591	-	170,124	467	295,903	-	**2,972,159**
61	Panama City Harbor, FL	-	91,520	1,459,597	934,683	9,105	113,645	-	-	-	24,418	-	1,411	-	254,629	-	**2,889,008**
62	Canaveral Harbor, FL	-	206,683	1,425	481,480	5,493	60,104	-	609,593	201,676	76,613	-	854,761	560	318,357	-	**2,816,747**
63	Brownsville, TX	-	677,102	246,001	793,726	101,379	72,561	-	751	-	15,080	2,059	284,362	-	454,877	6,895	**2,654,793**
64	Kahului Harbor, Maui, HI	-	200,781	1,900,487	432,237	25	3,923	-	23,366	-	396	-	-	-	24,994	21	**2,586,230**
65	Portsmouth Harbor, NH	-	-	104,529	563,771	-	-	242	-	-	-	-	1,624,452	-	-	-	**2,292,994**
66	Gulfport Harbor, MS	-	242,874	84,783	1,315	582,886	192,546	143,315	-	47,705	487,850	12	-	6	239,793	-	**2,023,084**
67	Port Jefferson Harbor, NY	-	-	361,740	1,493,646	-	-	-	-	-	-	3	162,689	-	-	-	**2,018,078**
68	Brunswick Harbor, GA	-	180,762	-	232,556	12,232	425,252	-	-	6,884	225,277	-	14,012	-	489,975	415,538	**2,002,489**
69	Ketchikan Harbor, AK	-	9,888	341,429	236,270	13,220	24,758	834,319	239,215	-	-	-	107,146	-	5,388	-	**1,811,633**
70	Port Angeles Harbor, WA	29,076	399,328	412,493	324,123	-	12,064	267,981	-	9,763	125,360	-	31,409	2,544	88,254	-	**1,702,395**
71	Pensacola Harbor, FL	-	155,394	266,468	917,890	71,633	27,558	-	-	-	11,573	-	29,321	-	142,378	-	**1,622,216**
72	Grays Harbor, WA	-	970,269	92,378	6,981	-	168,960	-	40,115	3,092	-	-	-	-	283,913	-	**1,565,708**
73	Chester, PA	-	73,990	1,844	239,797	114,262	31,001	-	-	96,205	49,072	-	360,449	-	422,347	-	**1,388,968**
74	Hilo Harbor, H.I.	-	29,858	977,168	296,627	-	1,321	-	39,743	-	953	-	-	-	8,695	-	**1,354,365**
75	San Diego Harbor, CA	-	96,211	61,874	51,905	15,372	175,040	114	74,928	21,209	88,937	-	424,203	308	214,916	126,464	**1,351,482**
76	San Francisco Harbor, CA	-	40,922	280,334	231,788	190,327	9,162	-	126,892	-	44,828	-	339,033	-	31,027	35,753	**1,330,066**
77	Stockton, CA	-	502,766	18	79,756	9,572	63,777	-	-	-	-	-	543,833	-	120,739	-	**1,320,462**
78	Bellingham Harbor, WA	-	136,586	137,414	229,866	36	198,755	196,793	-	13,044	17,996	-	149,053	-	211,788	42	**1,291,373**
79	Searsport Harbor, ME	-	123,312	102,308	314,943	6,847	118,826	-	-	-	13,218	-	518,486	-	64,771	-	**1,262,712**
80	Bucksport Harbor, ME	-	-	11,868	362,692	-	-	-	-	-	-	-	862,982	-	-	-	**1,237,542**
81	Georgetown Harbor, SC	-	722,330	64,023	4,578	-	211,292	-	-	-	-	-	-	-	231,170	-	**1,233,393**
82	Humboldt Harbor and Bay, CA	-	67,640	287,147	342,158	-	313,808	-	5,838	-	119,491	-	-	2,775	81,526	-	**1,220,383**
83	Olympia Harbor, WA	-	35,904	198,641	11,871	-	500	914,623	20,840	-	-	-	-	-	16,177	-	**1,198,556**
84	Salem Harbor, MA	-	746,356	-	277,132	-	-	-	-	-	-	-	124,829	-	49,099	-	**1,197,416**
85	Port of Richmond, VA	-	68,213	71,553	505,603	47,063	191	-	-	42,663	59,160	-	5,032	-	331,963	-	**1,131,440**
86	Sacramento, CA	-	399,399	95,323	6,449	7,809	156,108	-	-	-	192,158	-	107,562	-	172,648	-	**1,137,456**
87	Ponce Harbor, PR	-	61,397	12,293	-	590,149	34,108	3	285,282	6,943	2,543	-	60,277	-	81,120	-	**1,134,115**
88	Nawiliwili Harbor, Kauai, HI	-	112,958	974,743	25,887	3	-	-	13,451	-	-	-	-	-	2,570	-	**1,129,612**
89	Port Hueneme, CA	-	28,047	-	113,458	18,841	58,226	26	441	250,523	205,123	22,921	-	-	171,033	207,223	**1,075,861**
90	Port of Astoria, OR	-	589,618	130,418	73,155	-	50,219	-	-	-	-	-	-	2	133,184	-	**976,596**
91	Trenton Harbor, NJ	-	-	705,486	258,374	-	-	-	-	-	-	-	-	-	-	-	**963,860**
92	Port of Hopewell, VA	-	228,432	215,729	418,764	5,454	29,731	-	-	-	3,319	-	9,847	-	23,559	-	**934,835**
93	Weedon Island, Fl	-	-	-	900,766	-	-	-	-	-	-	-	-	-	-	-	**900,766**
94	Kawaihae Harbor, HI	-	-	860,713	11,834	-	-	-	-	-	-	-	-	-	-	-	**872,547**
95	Orange, TX	-	-	196,054	440,043	-	-	-	508	-	-	-	-	150	-	-	**636,755**
	Grand Total	**1,540,754**	**239,710,436**	**266,419,915**	**342,515,739**	**104,656,006**	**19,330,002**	**6,306,968**	**13,096,401**	**5,781,089**	**29,886,379**	**1,530,935**	**656,076,633**	**319,334**	**115,126,620**	**15,238,053**	**1,817,535,264**

Table 2-6. FIPS codes and county affiliations for Top 95 DSPs

Rank	Port Name	County	FIPS code
1	South Louisiana, LA, Port of	St. Charles/St James/ St John the Baptist	22089/22903/22095
2	Houston, TX	Harris	48201
3	New York, NY & NJ	Bronx/Essex/Hudson/Kings/ Middlesex New York/ Richmond/ Queens/Union	36005/34013/34017/36047/34023 36061/36085/ 36081/34039
4	Baton Rouge, LA	Ascension/Iberville/East Baton Rouge/West Baton Rouge	22005/22047/22033/22121
5	Valdez, AK	Valdez Court	02261
6	New Orleans, LA	Orleans/St. Bernard/ Jefferson	22071/22087/22051
7	Plaquemines, LA, Port of	Plaquemine	22075
8	Corpus Christi, TX	Live Oak/Nueces	48297/48355
9	Long Beach, CA	Los Angeles	06037
10	Mobile Harbor, AL	Mobile	01097
11	Tampa, FL	Hillsborough	12057
12	Texas City, TX	Galveston	48167
13	Port Arthur, TX	Jefferson	48245
14	Los Angeles, CA	Los Angeles	06037
15	Lake Charles, LA	Calcasieu	22019
16	Baltimore, MD	Baltimore City	24510/24005
17	Philadelphia, PA	Philadelphia	42101
18	Marcus Hook, PA	Delaware	42045
19	Portland, OR	Multinomaha	41051
20	Pascagoula, MS	Jackson	28059
21	Seattle, WA	King	53033
22	Paulsboro, NJ	Gloucester	34015
23	Newport News, VA	Newport News	51700
24	Beaumont, TX	Jefferson/Orange	48245/48361
25	Richmond, CA	Contra Costa	06013
26	Tacoma, WA	Pierce	53053
27	Freeport, TX	Brazoria	48039
28	Port Everglades, FL	Broward	12011
29	Savannah, GA	Chatham	13051
30	San Juan, PR	San Juan	72127
31	Jacksonville, FL	Duval	12031
32	Boston, MA	Suffolk	26025
33	Oakland, CA	Alameda	06001
34	Anacortes, WA	Skagit/San Juan	53057/53055
35	New Castle, DE	New Castle	10003
36	Norfolk Harbor, VA	Norfolk City/Virginia Beach	51710/51810
37	Portland, ME	Cumberland	23005
38	Honolulu, HI	Honolulu	15003
39	Kalama, WA	Cowlitz	53015
40	Charleston, SC	Charleston	45019
41	Galveston, TX	Galveston	48167
42	Matagorda Ship Channel, TX	Matagorda	48321
43	New Haven, CT	New Haven	09009
44	Barbers Point, Oahu, HI	Honolulu	15003
45	Wilmington, NC	New Hanover	37129
46	Vancouver, WA	Clark	53011
47	Providence, RI	Providence	44007
48	Miami, FL	Dade	12025

Table 2-6. FIPS codes and county affiliations for Top 95 DSPs (continued)

Rank	Port Name	County	FIPS code
49	Longview, WA	Cowlitz	53015
50	Albany, NY	Albany	36001
51	Camden-Gloucester, NJ	Camden	34007
52	Nikishka, AK	Kenai Peninsula	02122
53	Morehead City, NC	Carteret	39031
54	Wilmington, DE	New Castle	10003
55	Everett, WA	Snomish	53061
56	Coos Bay, OR	Coos	41011
57	Bridgeport, CT	Fairfield	09001
58	Fall River, MA	Bristol	25005
59	Anchorage, AK	Anchorage	02020
60	Palm Beach, FL	Palm Beach	12099
61	Panama City, FL	Bay	12005
62	Port Canaveral, FL	Brevard	12009
63	Brownsville, TX	Cameron	48061
64	Kahului, Maui, HI	Maui	15009
65	Portsmouth, NH	Rockingham	33015
66	Gulfport, MS	Harrison	28047
67	Port Jefferson, NY	Suffolk	36103
68	Brunswick, GA	Glynn	13127
69	Ketchikan, AK	Ketchikan/Prince Wales Ketchikan	02130/02201
70	Port Angeles, WA	Clallam	53009
71	Pensacola, FL	Escambia	12033
72	Grays Harbor, WA	Grays Harbor	53027
73	Chester, PA	Delaware	42045
74	Hilo, HI	Hawaii	15001
75	San Diego, CA	San Diego	06073
76	San Francisco, CA	San Francisco	06075
77	Stockton, CA	San Joaquin	06077
78	Bellingham, WA	Whatcom	53073
79	Searsport, ME	Waldo	23027
80	Bucksport, ME	Hancock	23009
81	Georgetown, SC	Georgetown	45043
82	Humboldt, CA	Humboldt	06023
83	Olympia, WA	Thurston	53067
84	Salem, MA	Essex	25009
85	Port of Richmond, VA	Henrico/Chesterfield	51087/51041
86	Sacramento, CA	Yolo/Sacramento	06113/06067
87	Ponce, PR	Ponce	72113
88	Nawiliwili, Kauai, HI	Kauai	15007
89	Port Hueneme, CA	Ventura	06111
90	Astoria, OR	Clatsop	41007
91	Trenton, NJ	Mercer	34021
92	Port of Hopewell, VA	Hopewell City	51670
93	Weedon Island, FL	Lee	12071
94	Kawaihae Harbor, HI	Hawaii	15001
95	Orange, TX	Orange	48361

Table 2-7. General ship-type groupings for ICST and VTCC codes

Ship-type [a]	ICST	ICST Description	VTCC [b]	VTCC Description
BA	321	Barge Carrier (Specialized)	15	Lash Vessel
BC	229	Dry Bulk (Other) Carrier	06	Bulk Carrier
BD	341	Open Dry-cargo Barge	40	Open Hopper Barge
BD	341	Open Dry-cargo Barge	47	Open Dry-cargo Barge
BD	342	Dry-cargo Covered Barge	41	Covered Hopper Barge
BD	349	Dry-cargo Other (Barge)	50	Container Barge
BD	342	Dry-cargo Covered Barge	48	Covered Dry-cargo Barge
BD	349	Dry-cargo Other (Barge)	49	RORO Barge
BD	343	Dry-cargo Deck Barge	46	Scow Barge
BD	349	Dry-cargo Other (Barge)	99	Other (Barge)
BD	349	Dry-cargo Other (Barge)	91	Semi-integrated Barge (Deleted)
BD	349	Dry-cargo Other (Barge)	90	Convertible Barge
BD	349	Dry-cargo Other (Barge)	51	Lighter Barge (Deleted)
BD	344	Dry-cargo Lash/Seabee Barge	52	Lash/Seabee Barge
BD	343	Dry-cargo Deck Barge	43	Flat/Deck Barge
BD	349	Dry-cargo Other (Barge)	45	Jumbo Barge (Deleted)
BD	349	Dry-cargo Other (Barge)	44	Pontoon Barge
BD	349	Dry-cargo Other (Barge)	42	Carfloat (Railroad Car Barge)
BL	143	Liquid Tank Barge (Double Sided)	72	Liquid Cargo Barge (Double Sided)
BL	149	Liquid Tank Barge (Other)	74	Other Liquid Cargo Barge
BL	144	Liquid Tank Barge (Double Bottom)	73	Liquid Cargo Barge (Double Bottom)
BL	141	Liquid Tank Barge (Single Hull)	70	Liquid Cargo Barge (Single Hull)
BL	142	Liquid Tank Barge (Double Hull)	71	Liquid Cargo Barge (Double Hull)
CS	310	Containership (Specialized)	07	Container
CS	336	General Cargo/Container	08	Partial Container
GC	335	General Cargo/Passenger	03	General Cargo Freighter
PA	351	Passenger (Cruise)	11	Passenger Carrier
PA	359	Passenger (Other)	16	Excursion/Sightseeing Vessel
PA	335	General Cargo/Passenger	12	Combination Passenger and Cargo
RO	333	General Cargo RORO/Container	09	Container/Vehicle/Trailer (RORO)
RO	334	Other RORO Cargo (General Cargo)	04	Break Bulk/RORO Carrier
RO	334	Other RORO Cargo (General Cargo)	05	RORO Vessel
RO	329	Other Carriers (Specialized)	13	Ferry
RO	329	Other Carriers (Specialized)	14	Railroad Car Ferry
SV	422	Offshore Support Vessel	02	Crewboat/Supply/Utility Vessel
TA	199	Liquid Other Tanker	24	Other Tanker
TA	199	Liquid Other Tanker	22	Liquid Bulk Tanker
TA	139	Liquid Gas Carrier (Other)	23	Liquid Gas Carrier
TA	120	Liquid Chemical Tanker	21	Chemical Carrier
TA	114	Liquid Oil Tanker (Oil/chemical)	20	Petroleum/Chemical Carrier
TUG	431	Tugboat	36	Tugboat/Towboat
TUG	432	Pushboat	35	Pushboat
UC	1	Unspecified Dry-cargo	1	Unspecified Dry-cargo
VC	325	Vehicle Carrier (Specialized)	10	Vehicle Carrier

[a] BA = Barge Carrier, BC = Bulk Cargo Carrier, BD = Dry-cargo Barge, BL = Liquid Cargo (Tanker) Barge, CS = Container Ship, GC = General Cargo, OT = Other and Unknown, PA = Passenger, Cruise and Excursion, RF = Reefer, RO = RORO and Ferry, SV = Supply Vessel and Support Vessel, TA = Tanker, TUG = Tugboat and Pushboat, UC = Unidentified Dry-cargo, VC = Vehicle Carrier

[b] Last two numbers of the 4-digit VTCC code. First two digits (not included) indicate general ship-type and material of construction..

SECTION 3

TYPICAL PORTS

3.1 PURPOSE

In addition to the data in Section 2 on the DSPs, it was necessary to acquire more detailed data that would allow determination of actual commercial marine vessel movements. In order to get this data, major ports in the U.S. were contacted and eight MEPA Areas were selected to provide data on the 25 Typical Ports that form the foundation of this report. The 1996 data on the Typical Ports will be used to do the following. Table 3-1 provides definitions for the unfamiliar terms.

- Calculate the total number of calls on each Typical Port
- Calculate the total number of shifts within each Typical Port where possible
- Determine vessel characteristics, by ship-type, for all vessels calling on the Typical Ports
- Determine modes of similar speed and operating characteristics
- Calculate the average time, by vessel type, in each of these modes (time-in-mode)

These efforts were carried out by using data from MEPAs with data on one or more of the Typical Ports, data from LMIS, and data from the pilots at each of the Typical Ports as shown in Figure 3-1.

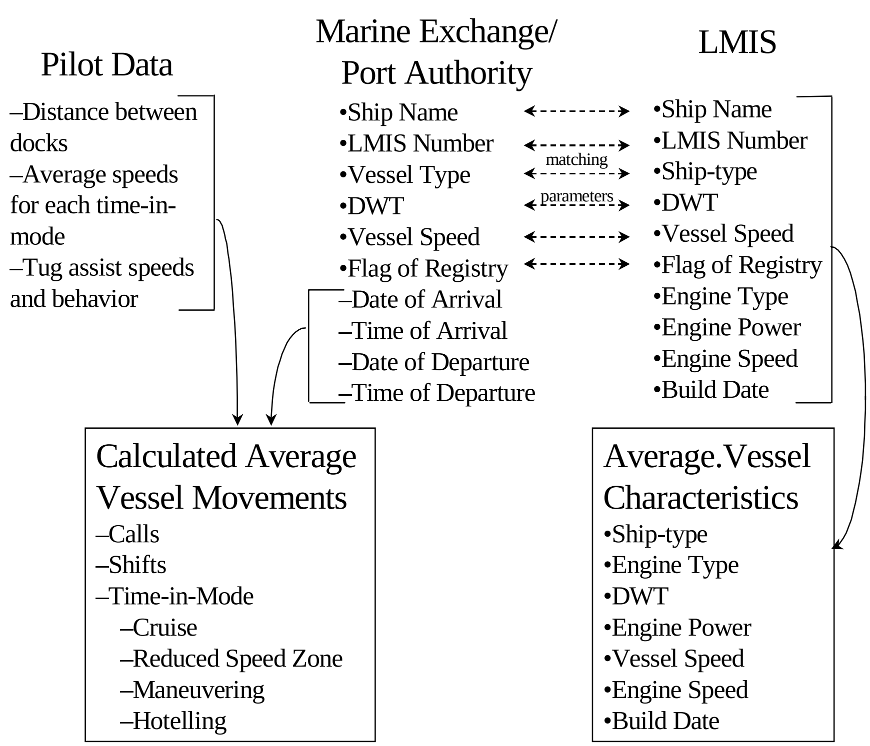


Figure 3-1. Data sources and relationships for Typical Ports

The following sections describe the data received from the three main sources, what calculations were performed on the data, and how the data were used together.

3.2 MARINE EXCHANGE/PORT AUTHORITY DATA

The data on vessel operations for each Typical Port came from the local port authority, marine exchange, board of trade, or other local organization with reliable information on vessel movements. Information was requested from many MEPAs on vessel movements for calendar year 1996. Useful data were received from the MEPAs of eight major deep-sea areas in the U.S.:

- Lower Mississippi River Ports (New Orleans, LA)
- Consolidated Ports of New York and New Jersey and Hudson River (New York Harbor)
- Delaware River Ports (Philadelphia, PA)
- Puget Sound Area Ports (Seattle, WA)
- Corpus Christi, TX
- Ports on the Patapsco River (Baltimore, MD)
- Port of Coos Bay, OR
- Port of Tampa, FL

These areas contain the Typical Ports and were chosen because of their size, diversity, and availability of electronic data recording vessel movements. The first five areas contain some of the largest ports and busiest waterways in the U.S. The last three are somewhat smaller but have unique geographic and ship-type characteristics. Coos Bay and Baltimore were chosen because of the predomination of foreign vessel calls. Tampa was picked as a port that had mostly domestic ship traffic. Some of these ports also have unique ship-type distributions. For example, Tampa has a great deal of barge traffic while Coos Bay has predominantly bulk carrier, general cargo, and tanker ship-type traffic. Data were purchased as available from the MEPA, which led to the acquisition of data detailing vessel movements for waterway areas such as the Lower Mississippi River, Puget Sound, and Delaware River rather than explicit vessel movements for unique USACE ports such as New Orleans, Seattle, and Philadelphia. Other ports were explored as possible sources of data for Typical Ports. A list of all the ports contacted and the data available from each port are presented in Appendix C.

Data were received in electronic format. Each MEPA sent a minimum of vessel name, date of arrival, time of arrival, date of departure, and time of departure. Some MEPAs also sent one or more of the following: Lloyds register numbers, flag of registry, ship-type, pier/wharf/dock (PWD) names, dates and times of arrival and departure from various PWDs, anchorages, next ports, cargo type, cargo tonnage, activity description, draft, vessel dimensions, and other information. For each MEPA, one record of data corresponded to one call on the MEPA, but may include shifts between ports located in the MEPA.

The electronic data received from the MEPAs provided a way to determine what a typical call looked like in each Typical Port. The following elements were useful in characterizing a typical call:

- Total time the vessel was in port
- Port(s) of call within the MEPA
- Vessel characteristics (using LMIS vessel characteristic data)

3.2.1 A Typical Call

A typical vessel call could be described as a vessel coming from the open ocean to a waterway area, being boarded by a pilot for that waterway, reducing speed and maneuvering through the waterway to the destination port, docking at the port with assistance from one or more tugboats, offloading cargo, refueling (bunkering), loading on more cargo, calling for a new waterway pilot and tug assist, getting underway from the dock, maneuvering out of the waterway, dropping off the pilot near the entrance to open water, and finally returning to the open ocean. There is, however, a large degree of variability in this pattern. Ship-type, fuel, total ship weight, harbor geography, speed zones in the port, weather, and schedule can all affect the length and duration of a call on an MEPA waterway. Section 3.5 further discusses the factors affecting a typical call.

3.2.2 Vessel Movements

The description of a vessel's movements during a typical call is best accomplished by breaking down the call into sections that have similar speed characteristics. Vessel movements for each call per ship-type category are described by using four distinct time-in-mode calculations. Each time-in-mode is associated with a speed and, therefore, an engine load that has unique emission characteristics. While there will be variability in each vessel's movements within a call, these time-in-modes allow an average description of vessel movements at each port. Time-in-modes were calculated for each vessel call occurring in calendar year 1996 over the waterway area covered by the corresponding MEPA. The specific time-in-modes for each vessel are then combined into averages per call for the ship-type category. The time-in-modes are described in Table 3-1.

Maneuvering and RSZ time-in-modes are estimations calculated from conversations with the waterway pilots on speeds and distances between landmarks in the waterway. Most harbor areas do not have specific RSZs, but speeds slower than service speed are typical once the harbor pilot boards the vessel. Each pilot is responsible for the ship's wake and any damage produced by the vessel's passage in the waterway. A pilot usually considers any speed less than service speed to be maneuvering although this report distinguishes between RSZ and maneuver, defining RSZ as the speed in open or somewhat congested water at speeds between 5 and 15 knots, and maneuvering as the time at speeds under 5 knots used for movements in close proximity to a PWD or anchorage.

Table 3-1. Vessel movements and time-in-mode descriptions within the MEPA Areas

Summary Table Field	Description
Call	A call is one entrance and one clearance from the MEPA Area. Depending on the size of the MEPA area and the specific call in question, a call may be equal to one entrance and one clearance in the USACE data or it may be equal to a combination of entrances and clearances from several ports within the MEPA Area.
Shift	A shift is a vessel movement within the MEPA Area. Shifts are contained in calls. While many vessels shift at least once, greater than 95% shift three times or less within most MEPA areas. Not all MEPAs record shifts (See Table 3-2).
Cruise (hr/call)	Time at service speed (also called sea speed or normal cruising speed) usually considered to be 85-95% of the maximum continuous rating. Calculated for each MEPA Area from 25 miles outside of the breakwater. The breakwater is the geographic marker for the change from open ocean to inland waterway (usually a bay or river)
Reduced Speed Zone (RSZ) (hr/call)	Time in the MEPA Area at a speed less than cruise and greater than maneuvering. This is the maximum safe speed the vessel uses to traverse distances within the waterway, and is usually 60 to 90% of cruise but ranges from 15 knots in the open water of the Chesapeake Bay to 5 knots in some of the more restricted waterways of the Port of New York and New Jersey. RSZ often occurs from the breakwater or waterway entrance until maneuvering starts, and then again when the vessel is clearing the waterway.
Maneuver (hr/call)	Time at dead slow or reverse. Dead slow is usually 2 to 5 knots and maneuvering is often carried out at a 3 to 4 knot average for the last 2 miles before the vessel reaches its PWD or anchorage. Thus typical maneuvering time is 1 hour per PWD and 0.5 hours per anchorage round-trip. Once the vessel reaches the PWD, the propulsion engines are still in operation during tug assist. The power load during this final segment of docking is transient and difficult to predict.
Hotelling (hr/call)	Hotelling is the time at PWD or anchorage when the vessel is operating auxiliary engines only. Auxiliary engines are operating at some load conditions the entire time the vessel is manned, but peak loads will occur after the propulsion engines are shut down either because the auxiliary engines are then responsible for all onboard power or because they are being used to power off-loading equipment, or both.

There are many variables that affect one or more time-in-mode calculations. These variables cannot be accurately predicted for a ship-type category over an entire year of calls. Traffic conditions, weather, vessel schedule, and current are some of the more important variables that dictate how much time is required at each time-in-mode, especially maneuvering. Traffic conditions may make travel in the waterway slower because a wake is more damaging in a congested waterway, forcing vessels to be more careful and travel at slower speeds. Bad weather in the form of high winds cause vessels to be more difficult and less predictable to maneuver; rain and fog obscure visibility and can make a vessel's maximum speed in the waterway a third of what it would be on a clear day. Docking takes much longer in bad weather and on busy days leading to more time at maneuvering speeds. Time of day and time of year may affect both weather and traffic, although in different ways. The waterway pilot is at least partially responsible for keeping the vessel on schedule to meet the tug assist for docking, the loading or unloading crews, and/or the bunkering vessel. If a vessel is ahead of schedule, the pilot may use slower speeds in the waterway to conserve fuel and arrive closer to schedule. If the vessel is behind schedule, the pilot may push speeds to the maximum safe limit in an attempt to get back on schedule.

Table 3-2. MEPA vessel movement and shifting details

MEPA Area and Ports	MEPA Data Includes
Lower Mississippi River including the ports of New Orleans, South Louisiana, Plaquemines, and Baton Rouge	Information on the first and last PWD for the vessel (gives information for at most one shift per vessel). No information on intermediate PWDs, the time of arrival at the first destination PWD, or the time of departure from the River.
Consolidated Port of New York and New Jersey and other ports on the Hudson and Elizabeth Rivers	All PWDs or anchorages for shifting are named. Shifting arrival and departure times are not given. Maneuvering and hotelling times are estimated from average speed and distance rather than calculated from date and time fields.
Delaware River Ports including the ports of Philadelphia, Camden, Wilmington and others	All PWDs or anchorages for shifting are named. Shifting arrival and departure times are not given. Maneuvering and hotelling times are estimated from average speed and distance rather than calculated from date and time fields.
Puget Sound Area Ports including the ports of Seattle, Tacoma, Olympia, Bellingham, Anacortes, and Grays Harbor	All PWDs or anchorages for shifting are named. Arrival and departure dates and times are noted for all movements, allowing calculation of maneuvering and hotelling both for individual shifts and the overall call on port.
The Port of Corpus Christi, TX	Only has information on destination PWD and date and time in and out of the port area. No shifting details.
The Port of Coos Bay, OR	Only has information on destination PWD and date and time in and out of the port area. No shifting details.
Patapsco River Ports including the port of Baltimore Harbor, MD	All PWDs or anchorages for shifting are named. Shifting arrival and departure times are not given. Maneuvering and hotelling times are estimated from average speed and distance rather than calculated from date and time fields.
The Port of Tampa, FL	All PWDs or anchorages for shifting are named. Arrival and departure dates and times are noted for all movements, allowing calculation of maneuvering and hotelling both for individual shifts and the overall call.

Another exception to average maneuvering times occurs when the vessel shifts between nearby docks or anchorages. Time spent shifting is fairly quantifiable and is treated as occurring at maneuvering speed in most instances. While almost every record for each of the eight MEPA Areas had entrance and clearance times for vessels using the harbor area, there was a varying degree of information on vessel movements within the MEPA Area. Some of the areas, such as the Puget Sound Area Ports, the Ports of New York/New Jersey, the Delaware River Ports, the Port of Tampa, and Baltimore Harbor, record every movement, whether external from the open ocean or internal from the inland waterways. Table 3-2 presents more information on the level of detail in the MEPA data that determined the level of detail of calculations for time-in-mode for shifting at each Typical Port. Shifting activities have proved problematic for other studies and reports of marine vessel movements. See Section 3.5 and Section 5.1 for further discussion of shifting on time-in-mode calculations.

3.3 LLOYDS MARITIME INFORMATION SERVICE

After receiving data from each MEPA, every available Lloyds Register Number (LRN) and vessel name were sent to LMIS. The vessel characteristic database used for this report was purchased from LMIS. A list of LRNs and ship names were sent to LMIS, which replied with ship characteristics for each of these ships. Vessel characteristics included in the database are vessel name, vessel type, service speed, engine power, date of build, engine revolutions per minute (rpm), flag of registry, agent, and DWT. Table 3-3 presents the fields provided by LMIS that were used to create average vessel characteristics per ship-type as shown in the summary tables for each specific port. Table A-1 in Appendix A, shows all of the fields provided by LMIS.

Table 3-3. Relevant LMIS fields and descriptions

LMIS Field	As used in report	Description
Ship Type - A	Ship-Type	Ship-type classification as defined for Lloyds Register Statistical Tables. This ship-type was modified to group similar ship-type classifications as shown in Table 2-7.
Stroke Type	Engine Type	The field had values of “2” for two stroke engine, “4” for four stroke engine, and was left blank for steam turbines.
DWT	DWT (tonnes)	Summer DWT. The maximum amount of cargo the vessel is capable of handling measured in metric tonnes (1000 kg per metric tonne)
Speed	Vessel Speed (knots)	Service speed of the vessel measured in nautical miles per hour (knot). (1 knot = 1.151 statute miles per hour)
BHP	Engine Power (hp)	Power in brake horsepower of new or refurbished engines. Steam turbine power was given by LMIS in kW but converted to horsepower for this report. (1 hp = 0.7567 kW)
RPM	Engine Speed (rpm)	Engine rpm at rated power.
DOB	Date of Build	Year of delivery to the fleet or last date of engine refurbishment.

LMIS, headquartered in Stamford, CT, offers the largest database of commercially-available maritime data in the world. Their data are from databases maintained by their two parent companies, Lloyd's Register of Shipping and Lloyds' of London Press, Ltd. Data purchased from LMIS reflect the Lloyd's Register Book, which is updated daily with reports from more than 1,900 LMIS surveyors and is the authoritative source of technical information about ships. The LMIS main database includes 86,000 ships.

There are many ship-type designations given by LMIS. One of the challenges of categorizing vessel movements by ship-type categories was to determine what ship-types were similar and could be grouped together. The groupings for each Typical Port are given in the section of this report devoted to that Typical Port. The major classifications used in each ship-type category were shown in Section 2, Table 2-2.

For each MEPA Area's summary table, three parameters – ship-type, engine-type and DWT range – make up a ship-type category. The engine type indicates if the ship is driven by a two-stroke engine, a four-stroke engine, or a steam turbine. For marine applications, a two-stroke engine usually indicates a slow-speed engine and a four-stroke engine usually indicates a medium-speed engine. DWT ranges were picked to give a fairly equal distribution of calls across the various ranges and ship-types. An example of a ship-type category used in this report is a bulk carrier with a two stroke engine that has less than 25,000 DWT.

3.4 PILOT DATA

Information from pilot associations and tide books were invaluable to the calculation of time-in-modes. A harbor pilot will often board a vessel near the breakwater. This transfer takes place while the pilot's vessel and the vessel calling on the MEPA are traveling at a reduced speed of 5 to 7 knots. The harbor pilot takes over from the main pilot and coordinates with any tugs that are going to assist the vessel in docking. Many times, it is this boarding by the harbor pilot and the subsequent record keeping that allow the MEPAs to have such detailed records of vessel activity.

Pilots at all of the MEPA waterways were contacted and asked about typical operations, including speeds by vessel type. Information on reduced speeds in a typical waterway were obtained by conversations with knowledgeable personnel at the MEPA and, when possible, directly from the pilots responsible for actually handling the vessels in the waterway. Therefore, vessel movements were calculated from the MEPA data, and any inconsistencies or lack of data were qualified and resolved by discussions with the pilots. The data they provided were used to supplement the data in the electronic files and to form a more complete record of each time-in-mode.

3.5 CALLS, TRIPS, AND SHIFTS

Within the MEPA boundaries, there are often one or more USACE-recognized ports/waterways. As stated in Section 2, an entrance or a clearance from a DSP is a trip. As stated in Table 3-1, a call is one entrance and clearance from an MEPA waterway. A challenge is presented when using both the MEPA call data and

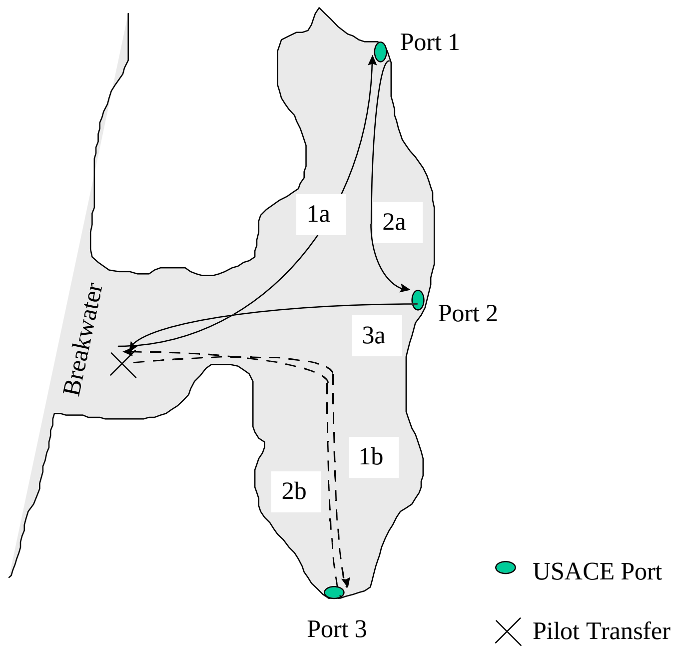


Figure 3-2. Vessel movements within an MEPA

the USACE trip data to characterize a port, as one call can be two *or more* trips. This is due to the fact that a movement between DSPs that lie within an MEPA Area is counted as a shift by the MEPA, if it is counted at all, and as two trips, one clearance and one entrance, by the USACE. To further complicate the reconciliation of MEPA and USACE data, a movement between PWDs within a port is considered an intraport movement while a movement between ports is considered an internal movement by the USACE while both are considered shifts by the MEPA (if the MEPA records them at all). Internal and intraport movements have different time-in-mode characteristics. Table 3-4 presents two vessels moving within the same MEPA waterway in order to give an example of the challenges of using the MEPA and USACE data together. Ports 1, 2 and 3 represent USACE DSPs. The movements described in Table 3-4 are shown graphically in Figure 3-2.

Table 3-4. Vessel movements within an MEPA explained

Vessel	Activity	Trips	Calls	Shifts
Vessel “a”	Enters breakwater. Pick up pilot at X. Proceeds to Port 1 (1a). Unloads wheat at Port 1. Proceeds to Port 2 (2a). Loads rice at Port 2. Maneuvers out of dock at Port 2, drops off pilot at X (3a), and exits the breakwater.	4	1	1
Vessel “b”	Enters breakwater. Picks up pilot at X. Proceeds to Port 3 (1b). Unloads granite, loads wood, and bunkers at Port 3. Maneuvers out of dock at Port 3, drops off pilot at X (2b) and exits the breakwater.	2	1	0

Vessel “b” follows nearly identical paths in and out of the MEPA Area. Vessel “a”, on the other hand, has a long leg from X to Port 1, a fairly short jump from Port 1 to Port 2, and another leg from Port 2 to X. The total distance traveled for Vessel “a” is not twice the distance to Port 1 nor twice the distance to Port 2 from X, but is half of each of these plus the distance between Ports 1 and 2. This example shows why it is not possible to simply treat the number of MEPA calls as half the number of USACE trips. After a cursory look at this example, one might ask why it is not possible to treat the number of trips as twice the number of calls plus twice the number of shifts. In theory, this should work. However, MEPAs do not keep sufficiently detailed records to track all shifts.

Shifting activities have proved problematic for other studies and reports of marine vessel movements. Many past reports on marine inventory and vessel movements have focused on entrance and clearance times for ships from a port area, and have not depicted movements within a port area. Although some vessels will enter a port, call on one dock, and then exit back to intracoastal waters, other vessels will come into the port area to one anchor or PWD and then proceed to another anchor or PWD within the same port area. Many shifts take place between nearby or adjacent docks, but they often take place between docks or anchorages that might be several miles part. Especially for the large waterway areas of New York and Puget Sound, shifting activities may greatly increase the amount of time per call during which a vessel’s propulsion engines are in operation.

If internal shifting is not included in the time-in-mode calculations, one of two things occurs. Either each call on a dock is treated as a call from the open ocean and is allotted time at cruise, reduced speed, and maneuvering, thereby resulting in overestimation of these time-in-modes and emissions for the call. Or, internal shifting is ignored and the call is treated as one docking event, resulting in underestimations for maneuvering and overestimations of hotelling, leading in turn to an underestimation of emissions for the call. This report includes shifting in the time-in-mode calculations. No further adjustments to the time-in-mode calculations need to be made for the Typical Ports to account for shifting.[2]

Because time-in-modes have been calculated as hours/call, and because the only data on a majority of the DSPs are available by trips, a detailed methodology for using both the MEPA data for the Typical Ports and USACE data for the DSPs to determine vessel operations for the DSPs was required. This methodology is discussed in Section 4.

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[2] Further adjustments for shifting will need to be made in the port summary tables for the ports of Corpus Christi, Coos Bay, and the Lower Mississippi River (Baton Rouge, New Orleans, Port of South Louisiana, and Plaquemine) as shifting data become available from each port’s MEPA.

SECTION 4

METHOD TO DETERMINE TIME-IN-MODES FOR DSPS

Part of the purpose of this report is to provide a detailed assessment of commercial marine activity for the Top 95 U.S. Deep-Sea Ports. This will be done by using the MEPA time-in-mode data, discussed in Section 3 and presented in Sections 6 through 14 in conjunction with the DSP data from the USACE presented in Section 2. A methodology is needed that will allow these two types of data to be used together. This methodology must address how to allocate three sets of factors:

- Time-in-mode data developed for a MEPA Area to the DSPs within the MEPA Area (Typical Ports)
- Time-in-mode data developed for a MEPA Area to a DSP not within the MEPA Area (Modeled Port)
- Unspecified dry-cargo (UC) to ship-types given by the Typical Port data

Several terms will be used throughout this section to designate different deep-sea traffic ports and waterways. Some of these have been used previously in the report, but for completeness they are also included in the summary of terms and definitions in Table 4-1.

The MEPA datasets used to calculate time-in-mode data for the Typical Ports chosen by EPA are developed differently from the USACE/Census Bureau data used to develop the trips and tonnage for the DSPs. This presents challenges in matching the data from the Typical Ports with the data from the DSPs. Each MEPA records vessel traffic for one or more Typical Ports. In most cases several USACE Ports are included in the MEPA Area and are not treated as distinct waterways in the database maintained by the MEPA. Thus, a methodology is needed to distribute time-in-mode data developed for the MEPA Area to the individual Typical Ports within the area. Once time-in-mode data are developed for the Typical Ports within a MEPA Area, these data will be used to determine time-in-modes for the Modeled Ports outside the MEPA Area relieving the modeler of the need to directly quantify (i.e. obtain data from a MEPA or other direct source) marine activities at the Modeled Port. Finally, some of the dry-cargo ships in the USACE data are undefined. As no time-in-mode data were developed for undefined ship-types, must be allocated to other, defined dry-cargo ship-types. The activities for UC ship-types listed in the DSP data must be allocated to ship-types recorded by the MEPAs.

Table 4-1. Port terms and explanations

Term	Explanation
MEPA Area	Waterways with detailed vessel information provided by a MEPA (see Section 3). Includes one or more Typical Ports (see below). Time-in-mode data were developed for each MEPA Area: • Lower Mississippi River Ports • Consolidated Ports of New York and New Jersey and Hudson River • Delaware River Ports • Puget Sound Area Ports • Corpus Christi • Ports on the Patapsco River • Port of Coos Bay • Port of Tampa
USACE Port	A port area as defined by the USACE. All of the DSPs are USACE Ports.
DSP	USACE Port ranked as one of the Top 95 DSPs in the U.S. by tonnage handled in calendar year 1995. One of the ports listed in Section 2, Tables 2-4 and 2-5.
Typical Port	USACE Port in a MEPA Area. A Typical Port is one of the DSPs and may be a Modeled Port or a Like Port (defined below).
Modeled Port	One of the DSPs for which time-in-mode data are required by a modeler
Like Port	One of the DSPs that is a Typical Port and has been determined to be similar to the Modeled Port
PWD	Piers, wharves, and docks: a place in the port where a vessel would hotel. Berths and anchorages are also places of hotelling and terms used by the MEPA. For the purposes of this section, PWD encompasses all of those terms.

4.1 OUTLINE OF THE METHODOLOGY

The methodology described in full in Sections 4.2 and 4.3, proceeds as follows:

- A Modeled Port is determined
- The Modeled Port is located in Table 2-4
- If the Modeled Port is within a MEPA Area then it is a Typical Port and Steps 2 through 5 should be carried out.
- If the Modeled Port is not within a MEPA Area then it is not a Typical Port, and therefore, a Like Port, that is a Typical Port, must be determined using Step 1 followed by the determination of trips and calls in Steps 2 through 11 below.

For purposes of illustration, examples of Steps 1 through 11 are given using the Port of Stockton, CA as the Modeled Port.

4.2 METHODOLOGY

4.2.1 Step 1. Determine a Modeled Port and a Typical Port

Each of the MEPA Areas has *one or more* DSPs contained within its boundaries. However, there are many other DSPs that are *not* in one of the MEPA Area. The first step in using the USACE and MEPA data to determine marine activities for the DSPs is to determine whether the Modeled Port is within a MEPA Area, and if not, to determine what Typical Port within a MEPA Area is most like the Modeled Port. Some of the DSPs are Typical Ports and will have marine activities determined through the methodology given in Steps 2 through 5 only. However, the other DSPs will use the MEPA data by seeking out a Typical Port most like the Modeled Port. For purposes of illustration, Stockton, CA will be the Modeled Port. It is not within the bounds of any of the MEPA Areas in Table 4-1 and it is, therefore, necessary to determine what port is a Like Port for Stockton.

Before determining which of the Typical Ports is the Like Port for the Modeled Port, it is necessary to determine which characteristics are best correlated with emissions. There are no proven methodologies for determining a Like Port. However, some possible characteristics to consider include:

- Geography and location
- Fleet composition (indicative of vessel characteristics, including average horsepower)
- Time-in-port/hotelling (indicative of time-in-mode)
- Distances at speeds (indicative of load and time-in-mode) within the port area
- Primary commodities handled
- Tons of cargo handled (indicative of load)

Vessel characteristics, time-in-mode, and load are important characteristics in determining a Like Port. Geography of the port and primary commodities handled are other characteristics that will influence both time-in-mode and vessel characteristics.

Every effort should be made to ensure that the Typical Port and Modeled Port are similar. It may even be necessary to check what other ports are near the “typical” and Modeled Ports. The following example indicates how vessel movements may be very different even within a similar geography. The Port of Coos Bay is located approximately 15 miles inland of the Pacific Ocean. By simply comparing geographic similarities, the Port of Longview, WA, may be considered similar to Coos Bay as it is also a port of some inland distance off the Pacific Ocean. However, the Port of Coos Bay is the only large waterway/port area accessible to vessels entering Coos Bay, but the Port of Longview is downstream of the Ports of Kalama and Vancouver. Thus, many vessels may pass by Longview on their way to Kalama or Vancouver, and emissions to each of these three ports may be overestimated or underestimated. It may be more accurate to compare Longview with one of the ports on the lower Mississippi River, although fleet composition and other factors may influence the appropriateness of that comparison as well.

By carefully using the bulleted factors listed above, it should be possible to determine which Typical Port to use as a Like Port for each port to be modeled. It is important to examine all of the factors when making a choice, as each will affect the quality and appropriateness of the resulting time-in-mode and ship-type characteristics resolved from the match.

Keeping these factors in mind, the port of Stockton, CA, will be treated in this section as being like Bellingham Harbor, one of the Typical Ports in the MEPA Area of Puget Sound. Both ports have similar geographies in that they are located many miles from the open ocean and vessels calling on the ports must pass through areas of other ports' ship traffic. Thus, it is expected that time-in-mode as well as geography and location will be similar. The two ports have similar ship-type compositions, as seen by comparing the ports in Table 2-4. These similarities are further detailed in the following steps.

4.2.2 Step 2. List USACE Port Codes Within the MEPA Area

Before it is possible to use Bellingham time-in-mode data for Stockton, it is necessary to determine the number of calls for Bellingham and any adjustments to the time-in-mode data developed for the overall Puget Sound area. In order to do this it is necessary to make a list of USACE port areas included in the MEPA Area of Puget Sound. To assist in this, a table of the Typical Ports included in the MEPA Area is given as the first table in each of the MEPA Area Sections, Sections 6 through 14 of this report. For some areas, such as Corpus Christi and Coos Bay, each MEPA may contain just one USACE port code, but for others, such as Puget Sound and Delaware River, there may be many Typical Ports.

To continue the example, Bellingham, our Like Port, is one of the Typical Ports listed in Table 4-2 within the Puget Sound area.

Table 4-2. Typical Ports within the Marine Exchange of the Puget Sound dataset

DSP Rank [a]	Typical Port	USACE Port Code
21	Seattle Harbor, WA	4722
26	Tacoma Harbor, WA	4720
34	Anacortes Harbor, WA	4730
55	Everett Harbor, WA	4725
70	Port Angeles Harbor, WA	4708
72	Grays Harbor, WA	4702
78	Bellingham Bay and Harbor, WA	4732
83	Olympia Harbor, WA	4718
NA	Neah Bay, WA	4706
NA	Port Townsend	4710
NA	Port Gamble	4714

[a] NA = Not Ranked in the Top 95 DSP

4.2.3 Step 3. Total All Trips for the Ports in Step 2

Using the total trips by ship-type in Table 2-4, the vessel trips are totaled, by ship-type, for each port/waterway in the Puget Sound (as listed in Table 4-2). These trips are shown as the first line in Table 4-3. The number of trips by ship-type for each port in each MEPA Area are given in the port-specific sections of this report, Tables X-3 of Sections 6 through 13. As mentioned earlier, UC ship-types are not recognized ship-types in the LMIS data and thus do not have corresponding time-in-modes in the MEPA data. These ship-types must be distributed over the other dry-cargo ship-types in the port. For the Typical Ports, we suggest allocating the total UC trips over the dry-cargo trips by ship-types using the percent of dry-cargo calls for each dry cargo ship-type as calculated from the MEPA Area data. Although it may seem odd to use the percent of calls to allocate trips, the MEPA data should accurately reflect the distribution of ship-types within the Typical Ports.

For Puget Sound, the percent dry-cargo calls are given in Table 9-2 and reproduced here in Table 4-3. Using bulk carrier or "BC" ship-type trips in the example, 33.2% of the dry cargo trips in the Puget Sound MEPA Area are BC. The revised BC trips in Table 4-3 were obtained by multiplying 1,392UC trips by 33.2% to get 462 "undefined, additional" trips to be added into the BC "As reported" ship-type trip totals. Thus the revised trips are 1,089 plus 462 for a total of 1,551 trips. This same allocation of UC trips should be calculated for all the ship-types. Table 4-3 presents the results of these calculations. This method of allocating the undefined ship-type trips is the default method. Any data available from the port or other reliable source that allows a more refined allocation of trips allotted to the USACE UC ship-type should be used in place of the above method.

Table 4-3. USACE and revised trips by ship-type for the Puget Sound area

Puget Sound Area	Ship-Types [a, b]									Total Trips
	BC	**CS**	**GC**	**PA**	**RF**	**RO**	**TA**	**VC**	**UC**	
A. As reported (Table 9-3)	1,089	2,107	338	80	85	628	1,000	845	1,392	7,564
B. % dry-cargo (From Table 9-2)	33.2%	42.8%	9.8%	0.5%	2.2%	6.2%	NA	5.3%	NA	100%
C. Undefined Addnl. (B.*UC)	462	596	136	7	31	86	0	74	-1392	0
D. Revised Trips	**1,551**	**2,703**	**474**	**87**	**116**	**714**	**1,000**	**919**	**0**	**7,564**

[a] BC = Bulk Carrier, CS = Container Ship, GC = General Cargo, PA = Passenger, RF = Reefer, RO = RORO, TA = Tanker, VC = Vehicle Carrier, UC = Unspecified Dry-cargo,
[b] Due to rounding, intermediate numbers may appear in error. Totals are correct as given.

4.2.4 Step 4. Determine Trips for the Like Port

Step 4 is similar to Step 3. Just as Step 3 was used to total all the trips for the MEPA Area containing the Like Port, so Step 4 is used to allocate the number of trips by ship-type to the Like Port within the MEPA Area. As stated previously, the number of trips by ship-type for each port in each MEPA Area are given in the port-specific sections of this report, Tables X-3 of Sections 6 through 13. Unless other information is available, it is recommend that UC trips be allocated over the other dry-cargo trips that are clearly recorded for the port. In each of the specific MEPA Area sections, this ratio is based on the percent dry-cargo calls as found in each Typical Port's MEPA data (as shown in Step 3 above).

To continue using the example of the Port of Stockton as the Modeled Port and Bellingham as the Like Port, Table 4-4 shows the trips, by ship-type, as reported by the USACE for the Port of Bellingham. The trip totals for the UC ship-types are 407. According to Table 9-2, the percent of dry-cargo calls for the BC ship-type over the entire MEPA Area is 33.2%. Assuming that this percentage applies to Bellingham, 33.2 % of 394 is 131 "undefined, additional" trips. Thus the total revised BC trips for Bellingham would be 24 plus 131 or 155 trips. This same process should be followed for all the ship-types. The second line of Table 4-4 shows the revised trips for all ship-type categories. Note that Table 4-4 shows the UC trip total as zero and the TA trips as unchanged.

Table 4-4. Reported and revised trips by ship-type for the Like Port, Bellingham, a Typical Port from the Puget Sound MEPA Area

Bellingham	Ship-Types [a, b]									Total
	BC	CS	GC	PA	RF	RO	TA	VC	UC	Trips
A. As reported (Table 2-4)	24	13	46	8	14	13	49	6	394	567
B. % dry-cargo (From Table 9-2)	33.2%	42.8%	9.8%	0.5%	2.2%	6.2%	NA	5.3%	NA	100%
C. Undefined Addnl. (B. * UC)	131	168	39	2	9	24	0	21	-394	0
D. Revised trips	**155**	**181**	**85**	**10**	**23**	**37**	**49**	**27**	**0**	**567**

[a] BC = Bulk Carrier, CS = Container Ship, GC = General Cargo, PA = Passenger, RF = Reefer, RO = RORO, TA = Tanker, VC = Vehicle Carrier, UC = Unspecified Dry-cargo,

[b] Due to rounding, intermediate numbers may appear in error. Totals are correct as given.

Rather than using a default methodology to allocate undefined ship-types at all the DSPs, it would be better to look for more data on the port in question, to find out the major types of cargo traded by the port, and to allocate the UC trips to that cargo and thereby that type of ship. For example, according to the Pacific Northwest Ports Handbook (Reference 4-1), the Port of Bellingham handles mostly break-bulk commodities and is also at the terminus of a large ferry system. Break-bulk commodities are usually carried on BC type vessels and ferries are included in the RORO ship-type category of this report. As such, a better estimate of actual vessel trips may be reached by allocating the UC trips to the BC and RO ship-types only.

While the method shown in Table 4-4 is the default method for allocating unknown ship-types, other methods can be used to produce better results as discussed in the previous paragraph. The default method should be used only when no better data are available.

4.2.5 Step 5. Determining the Number of Calls for the Like Port

The next step allows determination of the number of calls by ship-type reported in the MEPA database that should be allotted to the Like Port analyzed in Step 4. The total number of calls for each ship type must be multiplied by an appropriate factor derived from the results of the previous steps to give the number of calls by ship-type that are associated with Bellingham. Therefore, the revised trips by ship-type from Table 4-4 are divided by the revised trips by ship-type from Table 4-3. This yields a factor for each ship-type that, when applied to the total calls per ship-type for the whole MEPA Area, gives the total calls for the Like Port by ship-type.

To illustrate Step 5 with a continuation of the example, in Table 4-5 the total trips for the Puget Sound Area Ports and the total trips for Bellingham are allocated, by ship-type, to obtain each ship-type factor. Each factor is then applied to its respective ship-type's calls for Puget Sound yielding the calls by ship-type for Bellingham. The Puget Sound Area Ports section, Section 9, presents the total calls by ship-type for Puget Sound in Table 9-5, and shows the total calls as 3,241.

Table 4-5. Complete conversion of Puget Sound Trips to Bellingham Calls

	Ship-Types [a, b]								Total
	BC	**CS**	**GC**	**PA**	**RF**	**RO**	**TA**	**VC**	**Trips**
A. Revised Total Trips (Puget Sound) (from Table 4-3)	1,551	2,701	474	87	116	714	1,000	919	7,564
B. Revised Bellingham Trips (from Table 4-4)	155	181	85	10	23	37	49	27	567
C. Ship-Type Multiplier Factor (A/B)	0.100	0.067	0.179	0.115	0.194	0.052	0.049	0.029	.075
D. Calls for Puget Sound (From Table 9-5)	892	1,150	263	13	60	168	553	142	3,241
E. Calls for Bellingham (C*D)	**89**	**77**	**47**	**1**	**12**	**9**	**27**	**4**	**266**

[a] BC = Bulk Carrier, CS = Container Ship, GC = General Cargo, PA = Passenger, RF = Reefer, RO = RORO, TA = Tanker, VC = Vehicle Carrier

[b] Due to rounding, intermediate numbers may appear in error. Totals are correct as given.

Calls for Bellingham from Table 4-5 can be used with each of the four time-in-modes given in Section 9, Table 9-5, to develop total time spent in each mode by ship-type for Bellingham for the year. As each time-in-mode corresponds to a specific range of engine loads, these total times can be used with the appropriate emission factors to determine the total emissions. The time-in-modes developed for the MEPA Area summary tables in each MEPA Area section can be used without modification for cruise, maneuvering and hotelling. However, the time at reduced speed is dependent on the distance of the specific port from the breakwater or pilot's station; for MEPA databases that encompass several USACE Ports, a simple correction will allow a more representative RSZ time-in-mode to be developed as shown in Steps 6 through 8.

4.2.6 Step 6. Determine the Distance to the Port/Waterway

Each MEPA Area has variable distances from the breakwater or pilot's station to its Typical Ports. Even a MEPA that has only one Typical Port will have variable distances to the PWDs within the Typical Port. For some MEPA Areas most of the PWDs are in a relatively small area, and the distances between the bulk of the PWDs are negligibly different, but for other areas there are considerable differences in distance. Table 4-6 lists the MEPA Areas and which ones have PWDs within the port that are at a considerable distance from one another. A considerable distance for this purpose is considered to be more than 10 miles.

Table 4-6. Distances between piers, wharves, and docks within Typical Ports

Port	Distance between Piers, Wharves, and Docks
Lower Mississippi	Considerable
Hudson River	Considerable
Delaware River	Considerable
Puget Sound	Considerable
Corpus Christi	Negligible
Baltimore	Negligible
Tampa	Negligible
Coos Bay	Negligible

The distance between PWDs within the MEPA Area can be used to refine the RSZ time. Although distances from the breakwater to the Typical Ports within each MEPA Area are given in each MEPA Area's section, Steps 6 through 8 can be skipped for MEPA Areas with negligible differences (see Table 4-6) without significant impact to the overall RSZ time-in-mode.

Table 4-7 gives the Typical Ports in the Puget Sound and their RSZ distances from the pilots station at Port Angeles. Seattle could be considered the central Typical Port of the Puget Sound. The entrance to Seattle Harbor is 66 miles from the Port Angeles pilot station. As Seattle is the most commonly called upon port in Puget Sound, the average RSZ times by ship-type are naturally weighted for this distance although RSZ times for all calls in the MEPA Area were included in the average. Steps 7 and 8 will allow a modeler to calculate a better estimate of RSZ time for the other ports within Puget Sound that are both closer to and farther away from Port Angeles.

Table 4-7. Average distances to each Typical Port in Puget Sound

Typical Port	Distance from Port Angeles Pilot Pick-up (nautical miles)
Seattle Harbor	69
Tacoma Harbor	86
Bellingham	57
Grays Harbor (Aberdeen)	20
Port Angeles	3
Olympia	114
Everett	60
Anacortes	45

4.2.7 Step 7. Determine the Distance from the Breakwater to the Like Port

To determine how far the Like Port is from the breakwater or pilot's station, pilots books or the MEPA for each MEPA Area were consulted. These results are in the MEPA-sections of the report. The harbors in Table 4-7 are some of the most important harbors within Puget Sound. Distances are those given in the pilots book for Puget Sound (Reference 9-2) minus 2 to 3 miles for maneuvering.

4.2.8 Step 8. Compute RSZ for the Like Port

Divide the distance from the pilot's station or breakwater to the Like Port by the distance from the pilots station or breakwater for the average port in the MEPA Area. Multiply this ratio by the average RSZ time for the ship-type to obtain an adjusted RSZ time more representative of the Typical Port. This is shown in Equation 4.1 for Bellingham.

$$RSZ_L = RSZ_{AW}\left(\frac{D_L}{D_A}\right) \tag{4.1}$$

Where: RSZ_L = reduced speed zone time for the Like Port (ex. Bellingham)

RSZ_{AW} = reduced speed zone time for the average waterway (ex. Seattle, 16.5 hrs)

D_L = distance to the Like Port from the pilot's station or breakwater in miles (ex. 55 mi)

D_A = distance to the average waterway from the pilots station or breakwater (ex. 69 mi.)

To continue the example:

$$RSZ_L = 16.5\left(\frac{55}{69}\right)$$

$$RSZ_L = 13.1$$

Note: the modified RSZ time to use for Port Angeles using this methodology would be 0 hours. However, there will be some RSZ time associated with all ports as a vessel cannot shift instantaneously from full cruise to maneuvering. The minimum RSZ time to use assumes a vessel takes approximately 5 miles to slow from cruise to maneuvering for an average of 0.3 hours inbound and 0.3 hours outbound, for a total of 0.6 hours per call. A more precise minimum RSZ time per call can be computed by dividing 10 miles, the round-trip distance for deceleration and acceleration, by 65%[3] of the average speed per ship type from Table 9-5.

[3] The load for reduced speed zone was given by a Delaware River pilot as 60-70% of full load.

4.3 ALLOCATING TYPICAL PORT CHARACTERISTICS TO A MODELED PORT

Once Steps 6 through 8 associated with Equation 4-1 have been accomplished, the remaining task is to allocate time-in-mode characteristics from a Typical Port to a Modeled Port not located within the MEPA Area. A Typical Port is chosen to be the Like Port for the Modeled Port. After following Steps 1 through 8, average hotelling, cruise, and maneuvering times for the Like Port can be applied to the Modeled Port. However, the calls per year for each ship-type must now be calculated for the Modeled Port. Furthermore, RSZ time-in-mode must also be adjusted to account for the differences in the distance from the breakwater of the Modeled Port versus that for the Like Port. This is accomplished with the following steps.

4.3.1 Step 9. Determine Trips for the Modeled Port

The next step is to calculate the number of trips, by ship-type, for the specific Modeled Port. These data are available in Section 2, Table 2-4. Unless other data are available, it is recommend that the UC trips be allocated over the other defined dry-cargo ship-type categories. In the case of the Modeled Port, there will not be MEPA data to use to determine ratios of the dry-cargo calls. Therefore, the UC trips can be distributed using the ratio of the defined dry-cargo ship-type trips to the overall dry-cargo trips as shown in Equation 4.2. If a better method is available, such as the one described in Section 4.2.4, it can be used in place of the default method shown below.

$$ST_{rev} = ST_{rep}\left(1+\frac{UC}{DC_T}\right) \tag{4.2}$$

Where:

ST_{rev} = revised trips by ship type

ST_{rep} = reported trips by ship type

UC = unidentified dry-cargo trips

DC_T = total dry-cargo trips. Equivalent to Table 2-4 Grand Total trips minus BA, BD, BL, OT, SV, TA, TUG, and UC trips

To continue the example, Stockton, CA was chosen in Step 1 as the Modeled Port. The data in Table 4-8 came from Section 2, Table 2-4, for DSP number 77, Stockton. Stockton had, among other trips, 58 BC trips, 17 UC trips, and 74 DC_T trips shown for 1995. Using Equation 4-1 for Stockton bulk carriers, we get

ST_{rev} = ST_{rep}*(1 + UC/DC_T)

= 58 * (1 + 17/74)

= 71 revised bulk carrier trips

Table 4-8. Stockton trips as reported by USACE and as revised

Stockton	Ship-Types [a]									Total
	BC	CS	GC	PA	RF	RO	TA	UC	VC	Total
A. As reported	58	2	14	0	0	0	59	17	0	150
B. Undefined Addnl.	13	1	3	0	0	0	0	-17	0	0
C. Revised	**71**	**3**	**17**	**0**	**0**	**0**	**59**	**0**	**0**	**150**

[a] BC = Bulk Carrier, CS = Container Ship, GC = General Cargo, PA = Passenger, RF = Reefer, RO = RORO, TA = Tanker, UC = Unspecified Dry-cargo, VC = Vehicle Carrier,

4.3.2 Step 10. Compute the Number of Calls for the Modeled Port

For each ship-type in Step 9, divide the number of USACE trips for the Modeled Port by the number of USACE trips for the Like Port. The resultant is multiplied by the fraction of Like Port calls by ship-type as shown in Table 4-5.

To continue the example, Bellingham is the Like Port and Stockton is the Modeled Port. Both have traffic that is mostly bulk carrier and tanker. Bellingham has 155 revised BC trips. The 71 revised BC trips for Stockton divided by the 155 revised BC trips for Bellingham gives a fraction of 0.46. Multiplying the 89 BC calls for Bellingham by 0.46 yields 41 BC calls for Stockton. Table 4-9 shows the result of these calculations for all the ship-types of Stockton.

Table 4-9. Complete conversion of Stockton trips to Stockton calls

USACE Port/ Waterway	Ship-Types [a, b]								Total Trips
	BC	CS	GC	PA	RF	RO	TA	VC	
A. Revised Bellingham Trips (Table 4-4)	155	181	85	10	23	37	49	27	567
B. Revised Stockton Trips (Table 4-8)	71	3	17	0	0	0	59	0	150
C. Multiplier (B/A)	0.458	0.017	0.200	0	0	0	1.204	0	0.265
D. Calls for Bellingham (Table 4-5)	89	77	47	1	12	9	27	4	266
E. Calls for Stockton (C*D)	41	1	9	0	0	0	33	0	84

[a] BC = Bulk Carrier, CS = Container Ship, GC = General Cargo, PA = Passenger, RF = Reefer, RO = RORO, TA = Tanker, VC = Vehicle Carrier, UC = Unspecified Dry-cargo,
[b] Due to rounding, intermediate numbers may appear in error. Totals are correct as given.

4.3.3 Step 11: Compute the revised reduced speed zone

To compute a more accurate reduced speed zone time for the Modeled Port, divide the distance from the Modeled Port to the Modeled Port's breakwater by the distance from the Like Port to its breakwater. Use this ratio to adjust the Like Port's RSZ time-in-mode for the Modeled Port.

To conclude the example, Stockton is located approximately 80 miles from the entrance to the San Francisco Bay. Thus, 80 miles for Stockton divided by 55 miles for Bellingham is approximately 1.45 and the adjusted RSZ time for Stockton would be 1.45*13.1 = 19 hours. This RSZ would be reduced if it became evident that pilots meet vessels within the San Francisco Bay rather than at the entrance to the Bay.

4.3.4 Step 12: Allocation to Counties

Emissions from ports will likely need to be allocated to counties. Many ports are large enough that their boundaries encompass more than one county. For example, the Port of New Orleans is located on both banks of the Mississippi River from mile 81 to mile 115 on the river. Thus the port encompasses the city of New Orleans and the parishes (counties) of St. Bernard and Jefferson. If emissions from ports will need to be allocated to the county level, trips or the various time-in-modes must be allocated to the county level. The following are some possible methods of allocating ship traffic to the various counties that are within the port.

Method 1. Equal distribution: Divide the total number of trips for the port by the total number of counties. This is the simplest method and gives a straight forward equal allocation of trips to each county.

Method 2. Distribution by coastline distance: Divide the coastline distance of the county by the total coastline of the port (ex. If Baton Rouge has a total (both banks) of 228 miles of coastline and there are 4 counties within the port, determine the coastline distance of each county and divide it by 228 to get the fraction of emissions that should be allocated to the county.). This method seeks to allocate trips based on an actual geographic factor. Still a simple method but more complex and probably more accurate than Method 1.

Method 3. Distribution using average wind speed and direction. Get data on wind speeds and directions along the river. Allocate emissions to the counties downwind of the prevailing wind (either by Method 1) or 2)). This method has varying degrees of complexity depending upon the detail of the meteorological data used to determine the prevailing winds. This could be used to change the allocation to ports on a seasonal basis. This method may be more or less accurate than Methods 1 or 2 depending on the constancy of the prevailing winds.

Method 4. Distribution by berth density: Determine the density of activity (by counting the total number of berthing facilities in each county), total the berthing facilities in the overall port, determine the fraction in each county and use that fraction to determine traffic distribution. This method assumes that areas with more PWDs should have more emissions allocated to them. The port series reports published by the USACE for most major U.S. ports have detailed descriptions of PWD locations. For this method to be accurate, the level of activity at the majority of PWDs would be similar.

SECTION 5

DATA QUALIFIERS

Although the data and methodologies presented in Sections 1 through 4 are as accurate as possible, this section presents general data qualifiers for the data and methodologies in these sections. For data qualifiers specific to an individual MEPA Area, please refer to the specific section for that port.

5.1 QUALIFIERS FOR THE TOP 95 DSPS, USACE, AND CENSUS BUREAU DATA

5.1.1 Ship-Types for Top 95 DSPs

Census Bureau data were used for ships registered to a foreign flag because those data had more complete ship-type descriptions than the USACE data had for foreign flag vessels. Although both foreign and domestic vessels are included in the USACE database, for foreign ships, USACE only includes general ship-type descriptions such as self-propelled dry-cargo.[1] Further detailed ship-type descriptions, such as bulk carrier, container ship, or vehicle carrier, were given for domestic vessels only. For many records, the Census Bureau database did provide these detailed descriptions. The fields from the Census Bureau database gave the name of the vessel, the month the vessel call was recorded, the port/waterway code, the ship-type, the flag of registry, the last or next foreign port of call, the net registered tonnage, and the draft of the vessel.

When the detailed foreign ship-type data from the Census Bureau were combined with the detailed domestic ship-type data from the USACE, most of the ships did have detailed ship-type descriptions. Those dry-cargo records that did not have detailed descriptions were grouped into a category simply designated as "unidentified dry-cargo"(UC). Out of nearly 150,000 trips, less than 30% remained described as UC. UC includes trips with a vessel designated as part of the dry-cargo category as "other dry-cargo", but does not include the records designated as category 6, "other", which may include vessels from other ship-types.

As two databases were used to calculate the DSP data by ship-type, we compared the number of foreign vessel calls from the USACE by port/waterway with the number of foreign vessel calls by port/waterway from the Census Bureau. The match between the two databases was often quite good, although there are some waterways, such as Corpus Christi, that seem to use different port/waterway codes in the different databases, making it more challenging to match the correct ports. The overall deviation was found to be no more than 10% between the Census Bureau and the USACE data. For many ports, the difference was less than 1%.

In order to extract data on the DSPs trips by ship-type, it was necessary to query the large Microsoft ACCESS® database files grouping port/waterway code, by ship-type (VTCC or ICST) codes, and counting the number ICSTs in the group (foreign), or summing the number of trips for the group (domestic), and sum of

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[1] USACE general ship-types: 1 = dry cargo, self-propelled; 2 = liquid-cargo, self-propelled; 3 - tugboat/towboat, 4 = dry-cargo, non self-propelled; 5 = liquid-cargo, non self-propelled; and 6 = other

tonnage.[2] For the domestic data, it was necessary to query by traffic type and exclude records that were recording movements within the same port or waterway. The queries for the foreign entrances and clearances and the domestic light and loaded shipments and receipts were then combined into one Microsoft EXCEL® file to be sorted by a pivot table into records of trips by ship-type and tonnage by ship-type for each Top 95 DSP waterway. Some ICST (foreign vessels) and VTCC codes (domestic vessels) were grouped into general ship-type categories in the DSP files. These are shown in Table 2-7.

5.1.2 Trip Traffic

Trips in the USACE database have been defined here as either entrances to or clearances from a port. However, the USACE has many types of trips and codes to identify the type of traffic. Two of these trip types require particular attention. These two types show a trip that is a movement within a port or a movement from one port to a nearby port. These movements are called intraport and internal, respectively. Intraport movements are trips within the same port/waterway area. For instance, a trip to one berth in the Port of New Orleans from another berth or anchorage also in the Port of New Orleans would be an intraport movement. Intraport movements were not included in the DSPs' summary tables, as they denote shifts within the boundaries of one port and not entrances or clearances to a port from another waterway or port.

Internal trips are recorded when a vessel goes from one port/waterway area to another without leaving the internal waters of the United States. These internal waters are those of the Mississippi River, Chesapeake Bay, Delaware Bay, Great Lakes, Hudson River, Puget Sound, and San Francisco Bay. For instance, a vessel traveling from Wilmington, DE, to Philadelphia, PA, travels on internal waters only (Delaware Bay and River). In order to do this, the vessel entered the Delaware Bay breakwater, entered the port of Wilmington, cleared the port of Wilmington, and entered the port of Philadelphia, cleared the port of Philadelphia, and cleared the Delaware Bay breakwater. Thus, the DSP data would record trips for both Philadelphia and Wilmington for this one vessel.[3]

It is possible that the trips for internal and intraport traffic are analogous to shifts calculated from the MEPA call data. To continue with the above example, the Port of Wilmington would have one trip indicated from coastal waters and one trip indicated as internal. The Port of Philadelphia would likewise have one trip indicated as internal and one trip indicated as coastal. If the MEPA's correctly recorded all call and shift data and if the USACE correctly recorded all entrances and clearances with the proper traffic codes, a methodology might be developed that improves upon the one used in this report. For the DSPs, all internal and intraport traffic would be considered analogous to MEPA shifts and all other traffic would be considered analogous to MEPA calls. The

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[2] Census Bureau data represented one trip per record. while the USACE data contained a trip counter such that each record represented one or more trips.

[3] These same series of movements by this vessel would be recorded as one call and one shift in Section 8, Ports on the Delaware River Including Philadelphia, PA

time-in-modes could then be applied with more accuracy to the various Typical Ports within a MEPA Area. Cruise and RSZ times are independent of shifting as they apply only to the leg of the call that is coming from or going to coastal waters. Allotting Maneuvering and Hotelling to Typical Ports within the MEPA Area would be affected by the number of shifts per Typical Port. Preliminary investigations into these effects showed that treating internal and intraport traffic as shifts for the DSPs and allotting maneuvering based on trips plus shifts gave a less than 10% difference in allocation of maneuvering for all the Typical Ports. For most of the Typical Ports the difference was much less than 10%.

5.1.3 Data Format and Source

As stated in Section 2.1, data on the domestic trips for the DSPs came from the USACE Waterborne Commerce Statistics Center (Reference 2-1) for vessel trips in calendar year 1995, the latest year available when data were purchased. The data were received on floppy disk in four different files. These files reflect the two ways in which the USACE keeps track of waterborne commerce in U.S. waters. There are two cargo detail files (loaded shipments and loaded receipts) and two trips detail files (light shipments and light receipts). USACE does not maintain statistics on number of vessel trips by commodity. Vessel trips are associated with the vessel and its origin/destination.

The USACE receives data from operators of domestic vessels who send the origin, destination, commodity, date, and vessel type classification code (VTCC), which indicates the ship-type, to the USACE on a Vessel Operation Report form. This form is either a handwritten form that USACE provides, a printout from the operator similar to the USACE form, or an electronic file. The completeness, accuracy, and level of detail provided on these forms are subject in part to the vessel operator's enthusiasm, or lack thereof, for the task. When a Vessel Operation Report is received by the USACE, it may indicate that several commodities were moved on a given vessel. When this occurs, a cargo detail record is coded and keyed for each commodity. This can lead to many records in the cargo detail file indicating vessel moves having a zero or null value in the "trips" field. At most, one of the records gets a trip credited to it. In this way, double counting of vessels is avoided.

5.1.4 Exceptions to the USACE Count of Trips

While most vessel movements are reported to the USACE, and recorded by USACE as one trip per entrance or clearance from a port, there are several ship-types that are not recorded by the USACE. These include dredges and fishing vessels. No conflict arises in reconciling the USACE and MEPA data for these vessels because these vessels are rarely, if ever, recorded by the MEPAs. However, it is important to note that if these vessels are determined to be a significant source of emissions, another method of estimating activity other than the one presented in this report will have to be used.

Barges and tugboats are types of vessels recorded by the USACE but not by the MEPAs (with the known exception of Tampa, FL). Although barges are non self-propelled and rely on a tugboat for their motive power, tug and barge trips are recorded separately by the USACE. Although one tug may power one or more barges, barge/tug combinations are counted once for each vessel bottom (i.e. each barge is counted once and the tug is also counted). Thus, 10 barges and one tug would count as 11 trips (10 barge trips and 1 tug trip). As a result, it is impossible to determine from the USACE data which barges were associated with which tug or even how many barges were handled by a tug. Therefore, it cannot be assumed that, if a certain DSP had 1,200 tug trips and 1,200 barge trips, each tug movement was associated with one barge movement. It is just as likely that some of the tug movements were associated with more than one barge, and that some of the tug movements were not associated with any barge at all. Also, USACE does not record mooring tug trips. In summary, the data in this report do not provide a way to distinguish either how many barges were handled per tug or how many tug trips were associated with assisting self-propelled vessels to dock.

From our knowledge of self-propelled vessel docking, we could estimate that each ship-type recorded by an MEPA other than tankers (bulk carrier, general cargo, container ship, passenger vessel, reefer, vehicle carrier, and RORO) would require, on average, one tug to assist it in docking, and that tankers would require an average of two tugs per each docking. Fishing and miscellaneous vessels are not expected to require tug assistance. Using these estimates, a determination of the tug trips associated with barge moves and mooring could be estimated. For more information on tugs, see Section 14, "Tug Populations and Characteristics".

Due to the high volume of tug and barge trips, the USACE extrapolates tugboat trips and empty barge trips from a sampling of data. Tugboat moves are extrapolated from 70% or more of total tugboat moves and barge moves are extrapolated from 85% or more of total barge trips. In order to more accurately reflect what USACE regards as actual traffic patterns (e.g., inbound and outbound trip counts should be very similar), some adjustments are made by USACE to the trip counts in their databases. For example, if the Bulk Carrier entrances reported to USACE for the Port of New Orleans are a few hundred trips less than the Bulk Carrier clearances for that port, USACE may add a few hundred trips to the entrances when recording the data in their databases.

5.1.5 County Codes

In order to use the data generated by this report, EPA requested that the DSPs be matched with the counties that are within the port boundaries. Each county has an FIPS code[4] that EPA has associated with the DSP data. An FIPS code database called ZIPLIST5 was purchased over the Internet from http://www.zipinfo.com/products. Matching with FIPS codes was performed by searching the FIPS database for the city with the same name as the port. In most cases, port boundaries were not marked on the available maps. While several of the DSPs are listed in Table 2-6 as covering more than one county, there is a chance that some of the other DSPs also cross more than the county lines noted in the report. This is particularly likely for river ports

[4]FIPS codes are distinct unique numeric identification codes assigned to each county by the U.S. government.

(See Volume II, "Commercial Marine Activity for River and Lake Ports" for further discussion). Appendices B.1 through B.8 include discussions of the counties that are within the MEPA ports.

5.1.6 Seasonal Variation

Data received from the USACE included the month in which each trip was recorded.[5] Using this monthly data, we assessed the seasonal variations in the port activity by determining the percent variation for each month from the overall average. Ports that had less than a 10% variation for any month were considered to have little seasonal variation. Most U.S. DSPs have little seasonal variation in terms of trips. Exceptions to this are ports in the Great Lakes, Alaska, and other northern areas prone to heavy freezing in the winter. Some of these ports actually show no trips for December and January.

5.2 QUALIFIERS FOR THE TYPICAL PORTS AND MEPA DATA

5.2.1 LMIS Date and Matching Lloyds Register Numbers

As stated in Section 3, the LRN is a unique number assigned to a vessel. When data were requested from the MEPAs, it was requested that they include LRNs when available. LMIS keeps a master list of LRNs and uses the LRNs to index data on vessel characteristics. A list of LRNs and ship names was sent to LMIS, with a request for vessel characteristics. Matching the LRNs from the MEPA with the LRNs in the LMIS database of ship characteristics permitted the determination of speed, engine type, age, power, tonnage, and other ship-type characteristics. Some MEPAs, however, do not record LRNs. Even those MEPAs that do record LRNs have some gaps in their collected data. In order to match the MEPA data with the LMIS database, the first step was to match identical LRNs. Some vessels in the MEPA data did not have LRNs. For all of the MEPA Areas, some vessels were not matched after this first step. The following criteria were used, in the order shown, until all possible ships were matched with LRNs.

- Similar LRN, identical ship name, identical DWT, and identical ship-type
- Similar ship name, identical DWT, and identical ship-type
- Similar DWT and identical ship-type.

Where available, vessel speed, net registered tons, horsepower, operator and flag were also criteria used in this matching process. (See individual sections for the number of each ships for each MEPA that were not matched with LMIS vessel characteristics.)

When an LRN was not available from an MEPA, LMIS was asked to provide ship characteristics for every vessel with the same name as the MEPA vessel. Not only was it difficult to match the characteristics of MEPA vessels without LRNs in the database purchased from LMIS, it was also difficult to ensure that the data on the correct vessel were purchased from LMIS. An example of the possible errors that can be encountered if matches

[5] The date in which USACE records the trip is almost always within the same month that the trip actually occurred.

are made by ship name alone follows. As an LRN is unique but a ship name is not, when the MEPA did not supply an LRN, LMIS attempted to provide all LRNs for that ship name. However, ship names do change.

Complications might arise from this. For example, one of the ships in our request to LMIS was the ship “Victoria.” Fourteen different LRNs, for 14 different vessels, were returned as having the name “Victoria,” and they varied in ship-type, spanning General Cargo, Ferry, Fishing, Tug, Reefer, RORO, and Landing Craft. Now, suppose that the reefer “Victoria” recently changed its name to the “Chiller.” If the ship “Victoria” in our records is now the “Chiller” in LMIS’s records, and had called on an MEPA that does not record LRNs but simply supplied a DWT, ship-type, and vessel name it is probable that there would be an apparent mismatch in names between the two data sources. To help minimize any errors, close attention was paid to matching ship-types and relative sizes (DWT).

5.2.2 Typical Call

There is a large degree of variability in the pattern of a typical call. Ship-type, fuel-type, total ship weight, waterway geography, speed zones in the port, weather, and the vessel’s scheduled time of arrival can all affect the length and duration of a call on an MEPA waterway.

Container ships are generally faster than other dry-cargo vessels, both in their speed in the waterway and in their time at dock. It is well known that tankers typically call on more than one dock in a waterway. Ocean going vessels that use fuel oil or bunker “C” as their main fuel source may be required by law, or may voluntarily choose, to switch to marine diesel oil or other more volatile fuel when maneuvering as required in congested waterway areas. It takes 20 to 45 minutes to complete the switch from Bunker “C” to marine diesel oil, and this may impact how soon a vessel will reduce its speed in a waterway. However, vessels powered by steam turbines do not make this switch in fuel sources and, thus, do not need the extra time to reduce speed.

Some of the variability in the typical call can be predicted from the overall geography of the harbor or waterway area. If there are large stretches of fairly open water that a vessel must traverse before docking, the pilot is likely to increase the vessel back to a service speed or a somewhat reduced service speed from the 5-6 knot speed used when picking up the pilot. If the vessel is ahead of schedule the pilot will not proceed at the maximum safe speed but will, instead, proceed at a slower speed that will allow the vessel to dock as close to schedule as possible. Wind, rain, or other inclement weather can cause delays in vessel operations and lead to longer travel times at slower speeds. In the case of inclement weather, slower speeds do not necessarily correspond to reduced engine loads and lower emissions, as the vessel may be fighting increased currents or struggling just to maintain position.

The vessel’s scheduled time of arrival can also affect the time-in-mode, especially the time in RSZ. For instance, the maximum safe speed in the main channel of the waterway may be 15 knots, and a vessel may take an average of 2 hours to traverse the waterway at that speed. However, if the same vessel enters the main channel

3.5 hours before it is scheduled to tie up at the dock, it will proceed at a slower speed that is still appropriate for the waterway, perhaps 10 knots, and may therefore take 3 hours to cover the same distance.

5.3 QUALIFIERS TO DETERMINING THE TIME-IN-MODES

5.3.1 Matching Fleet Characteristics Between DSP and MEPA Ports

Fleet characteristics, such as the relative percent of each ship-type to the total number of calls, may be important when determining which MEPA port is the most appropriate Like Port for given Modeled Port. If a Like Port is chosen as a match for a Modeled Port but the Like Port happens to have zero ship calls for a ship-type that made a number of trips in the Modeled Port, there are two viable options. The first is to find another Like Port of similar geography and more similar fleet composition. The second is to continue using the first Like Port, but, for those ship-types showing no Like Port trips, take the Modeled Port trips, divide them by 2, and use the resulting number as the number of calls for that ship-type in the Modeled Port. This second option assumes that the ship-type did not shift in the port and is a gross approximation at best, and should only be used for a ship-type that has made but a small fraction of the overall number of trips.

5.3.2 Applying Data to Other Years

The most important factor in applying these data to other years will be in the ratio of calls between ship-types in the MEPA data. The absolute number of calls is secondary to this ratio, as the number of calls are themselves used as a ratio in order to incorporate shifting into the USACE data. Thus, if the composition of the overall fleet and the relative importance of each Typical Port within the MEPA port do not change significantly, then we would expect the data in this report to be applicable to other years, with relatively good accuracy, if the USACE data were updated to the year in question.

Another way of using these data for other years would be to obtain an estimate of overall change in the Modeled Port's activity from 1996 to the present. If the port handled 10% more traffic in 1998 than in 1996, 1998 totals could be estimated by following the methodology in this report and then increasing the final number of calls by 10% for all ship-types. For some ports, it is not uncommon for port activity to increase or decrease by 30% or more from one year to the next. The data in this report should be used with caution in estimating vessel activity in other years.

SECTION 6

PORTS OF THE LOWER MISSISSIPPI RIVER - GULF OUTLET TO BATON ROUGE, LA

6.1 DATA

Data were received from the New Orleans MEPA (Reference 6-1) for all commercial vessels that called in the waterways covered by the MEPA for calendar year 1996. Assistance on time-in-mode and normal vessel operations was received from the Crescent River Pilots (Reference 6-2). Ports and anchorages covered in the dataset range from Baton Rouge in the north to the South and Southwest Pass entrances in the South. Approximately 234 miles of Mississippi River, including the major deep-sea ports of South Louisiana, Baton Rouge, New Orleans, and Plaquemine, are covered in the dataset. The Inner Harbor Navigation Canal and Mississippi River-Gulf Outlet are USACE port/waterways that are within the area covered by the MEPA but neither area had any reported trips in 1995. Table 6-1 shows the Typical Ports, their DSP Port rank and their USACE Port/waterway code. More detailed information on the Lower Mississippi River is available in Appendix B.1.

Table 6-1. Typical Ports within the MEPA dataset

DSP Rank	Typical Port	USACE Port Code
1	Port of South Louisiana (above New Orleans)	2253
4	Port of Baton Rouge, LA	2252
6	Port of New Orleans, LA	2251
7	Port of Plaquemines (below New Orleans)	2255

The dataset received from the MEPA contains the information on the ship name, ship-type, vessel speed, time the first pilot arrived on the vessel and time the last pilot left the vessel, first destination dock, and time the vessel departed from the last berth or anchorage, and other information as shown in Appendix A, Table A-4. Data received from the New Orleans MEPA had LRNs for many of the ships. Out of 6,199 records, 4,280 automatically matched with our LMIS data base. The remaining ships were matched with LRNs by comparing ship name, ship-type, vessel speed, and DWT provided by the MEPA with LMIS data. If no LRN was available with ship name identical to the one in the MEPA database, a similar ship name with the same ship-type and similar DWT was selected. After this manual matching process, there were 44 records excluded from the summary Table 6-6 due to lack of data. The use of ship-type and DWT categories in the summary tables provides enough leeway to reduce the impact of small errors in the matching process. Each record in the MEPA database described a complete call on the Lower Mississippi River. A call is one entrance and one exit from the Lower Mississippi River as reported by the New Orleans MEPA.

Table 6-6, located at the end of this section, is a summary table of all the vessels recorded by the MEPA in 1996 presented by ship-type, engine type, and DWT range. Ship-types are those used by LMIS with similar categories grouped together for simplicity. Table 6-2 gives the number of calls and shifts per ship-type for calendar year 1996. Since detailed vessel movement data were not available for the Lower Mississippi, shifts are counted to be any vessel that has a different last berth than the first berth. Intermediate shifting is therefore not accounted for. It is probable that more shifts occurred in the Lower Mississippi River in 1996 than are recorded in Table 6-2.

Table 6-2. Calls and shifts by ship-type as recorded by the New Orleans MEPA for the Lower Mississippi River - Baton Rouge to Mouth of Passes

Ship-Type	Calls	Shifts [a]	% dry-cargo calls [b]
BARGE CARRIER	38	10	NA
BULK CARRIER	3,001	2,705	65.8%
CONTAINER SHIP	379	71	8.3%
GENERAL CARGO	911	511	20.0%
MISCELLANEOUS	21	13	NA
PASSENGER	152	7	3.3%
REEFER	14	4	0.3%
RORO	100	33	2.2%
TANKER	1,458	1,254	NA
TUG [c]	79	74	NA
VEHICLE CARRIER	2	2	0.1%
Grand Total	**6,155**	**4,684**	**100.0%**

[a] Shifts for the Lower Mississippi River Ports were calculated from incomplete data and are likely to under-represent the total number of actual shifts

[b] % of dry-cargo calls excludes calls from barge carrier, miscellaneous, tug, and tanker ship-types

[c] Represents a small fraction of total tugs operating in the Lower Mississippi

Some vessel types are only rarely reported by the MEPA. These vessels include ferries, tugs, barges, supply vessels, yachts, fishing vessels, and excursion vessels. There are a few of these vessels in the database that may be useful in developing default characteristics and time-in-modes, but these vessel types are not completely recorded, we have grouped them together in a "miscellaneous" category.

Table 6-3 presents a summary of USACE recorded trips, by ship-type, for the Typical Ports included in the New Orleans MEPA database. There is some discrepancy in ship-types between the USACE and the MEPA matches with LMIS. For example, fishing vessels are not a separate category recognized by the USACE. The "miscellaneous" vessels in the MEPA database may correspond with some of the "other" vessels in the USACE database, but more data is needed before emissions can be estimated for the vessels in these categories. The USACE trip totals in Table 6-3 should be used with the methodology in Section 4 to develop calls by ship-type for each Typical Port within the New Orleans MEPA MEPA Area.

Table 6-3. USACE trips by ship-type for each Typical Port within the New Orleans MEPA dataset

Typical Port		Ship-Type [a]									Trip
Rank	Name	BC	CS	GC	PA	RF	RO	VC	TA	UC	Totals
1	Port of South Louisiana	2,713	10	163	40	10	26	-	1,645	604	5,211
4	Port of Baton Rouge	1,171	33	194	33	-	3	-	1,079	325	2,838
6	Port of New Orleans	2,134	853	352	144	23	252	-	891	1,702	6,351
7	Port of Plaquemine	675	3	22	28	-	-	-	1,035	144	1,907
Ship-Type Totals		**6,693**	**899**	**731**	**245**	**33**	**281**	**-**	**4,650**	**2,775**	**16,307**

[a] BC = Bulk Carrier, CS = Container Ship, GC = General Cargo, PA = Passenger, RF = Reefer, RO = RORO, TA = Tanker, VC = Vehicle Carrier, UC = Unspecified Dry-cargo, .

[b] Trip totals do not include intraport movements (vessel movements within the same USACE port/waterway)

For purposes of distributing the MEPA calls in Table 6-2 to each Typical Port, we suggest allocating the UC trips over the dry-cargo ship-types using the percent of dry-cargo calls presented in Table 6-2. For example, the Port of New Orleans, has 1,702 UC trips. BC trips are 65.8% of the dry-cargo calls for the entire MEPA Area, and 65.8% of 1,702 is 1,120. Thus the total revised BC trips for the Port of New Orleans would be 2,134 plus 1,120 for a total of 3,254 trips. This same process should be followed for all the ship-types and all the port/waterways. This method of allocating the undefined ship-type trips is the default method. Any data available from the port or other reliable source that indicates a more refined allocation of UC ship-types trips should be used in place of the above method.

6.2 TIME-IN-MODE CALCULATIONS

Descriptions of each time-in-mode are given in Section 3, Table 3-1 of this report. The following descriptions are specific to calculations for the Lower Mississippi River.

6.2.1 Cruise

Cruise speed is the average continuous speed of the vessel in open water. Cruise is treated as beginning twenty-five miles out from mile zero on the River which corresponds to the entrance to either the South or Southwest Passes and is calculated by Equation 6.1.

Cruise = 25 / [Vessel Speed (knots)] * 2 **(6.1)**

6.2.2 Reduced Speed Zone

Reduced speed zone (RSZ) is the time-in-mode a vessel is at a speed less than full cruise and greater than the 4 knot average used for maneuvering. Vessels enter the Gulf at service speed and may continue at service speed or a reduced speed depending on weather and traffic until the vessel slows to pick up the River pilot. There are four different pilot associations associated with different areas of the River and Gulf. These are described in detail in Appendix B.1. Conversations with the Coast Pilots and Associated Branch Pilots suggest that the maximum and average speed in all sections of the River are 10 knots for all ship-types.

Based on this data we assumed that a typical vessel travels at 10 knots except for the last 2 miles before a berth or dock when they slow to an average of 4 knots for maneuvering. Although this formula is used to calculate an average time in the River, it should be noted that vessels are not often at constant speeds and that much of the RSZ time may be at transient conditions. Table 6-4 provides a summary of the major ports, their miles on the river, the average time to get to a berth within that port based on a 10 knot average speed in the river, and the total entrances by port (provided by the MEPA). It should be noted that the total entrances reflect the first destination of the vessel and do not include shifts or count vessels which call on a port after the initial call on the first berth or anchorage in the first port.

Table 6-4. Average time, distance, and arrivals by location to the major port areas on the Lower Mississippi River

Port/waterway Name	Approximate Mile on the River	Average Time (hr)	Total Calls [a]
Port of Plaquemines	2.4 - 91	0.5 - 9	978
Port of New Orleans	91 - 105	9 - 11	3,124
Port of South Louisiana	107 - 210	11 - 22	1,079
Port of Baton Rouge	220 - 334	22 - 35	463
Mississippi River Gulf Outlet [b]	9.3	1	555
Total			**6,199**

[a] Totals are from the New Orleans Board of Trade Annual Summary Report and include all ship-types and an additional 44 vessels that were excluded from the summary in Table 6-6 due to lack of data

[b] USACE recorded no trips to port/waterway 2060 Mississippi River Gulf Outlet, LA in 1995

RSZ time for the Lower Mississippi River was calculated by Equation 6.2.

$$\textbf{RSZ (hr/call)} = \textbf{(AtoB + BtoC + CtoD) / 10} \qquad \textbf{(6.2)}$$

Where AtoB = the miles from entrance Pass to the first berth minus 2 miles

BtoC = the miles from the first berth to the departure berth minus 4 miles

CtoD = the miles from departure berth to exit pass minus 2 miles

10 = 10 knots, the average speed in the River

6.2.3 Maneuvering

On the average, maneuvering starts two nautical miles from the dock and continues until the vessel is tied up. This is repeated as the vessel is leaving the dock for an average time-in-mode of 1 hour per berth. Thus maneuvering is equal to one hour for each berth (either one or two) plus one half hour for maneuvering through the pass plus one optional half hour if the first berth was located at mile 3 or less on the River.

6.2.4 Hotelling

Hotelling occurs when the vessel is at anchorage or at a berth and is the total time in the MEPA Area minus the time-in-mode for RSZ and maneuvering.

$$\text{Hotelling (hr/call)} = (\text{deptdate} - \text{passdate}) * 24 + (\text{deptime} - \text{passtime}) - (\text{RSZ} - \text{CtoD} / 10) - \text{Maneuver} \quad (6.3)$$

Where:

deptdate = Date of departure from the last dock

depttime = Time of departure from the last dock

passdate = Date the vessel arrives at the entrance Pass

passtime = Time the vessel arrives at the entrance Pass

and "maneuver", "RSZ", and "CtoD" are as defined in the previous sections.

6.2.5 Summary Table

The summary table, Table 6-6 reflects all of the ship-types, vessel characteristics, and time-in-mode data available for the Lower Mississippi River. There are some ship-type categories for which one or more of the data fields had no available data. These are marked "ND" in the summary Table 6-6. Engine speed was one of the least complete data fields in the LMIS data, and steam turbines do not have engine speed data.

There is a large standard deviation for many of the hotelling totals as a few vessels that stayed in port for repairs, retrofit or some other reason had hotelling times in the hundreds or thousands of hours. If one of these long hotelling times occurs for a ship-type category that only have a few calls, the average hotelling time will appear much higher than may actually be typical. In these cases, we recommend using the average hotelling time for the entire ship-type.

6.3 DATA QUALIFIERS

There are three main entrance and exit routes for the Lower Mississippi River. Two of them, South Pass and Southwest Pass, are near to each other and have similar characteristics. Both correspond to mile zero on the river. Mississippi River Gulf Outlet is the third option. It is another channel that branches from the main river exits at South and Southwest pass and has a mile marker of 9.3 miles rather than 0. These differences in distances are accounted for in the time-in-mode calculations.

Many fields did not have data for all records but the most important fields showing dates, times, ship-type, and ship name were more mostly complete. After calculating RSZ, maneuvering, and hotelling times for each call and shift, a visual inspection of the results was performed. Data that had negative times or excessively large times for any of the time-in-modes were examined for obvious inconsistencies. If an obvious inconsistency was found such as an arrival or departure date with a year other than 1996 (or in some very few cases, January of 1997) the year was changed to the appropriate year. Another somewhat common error would be a departure time late in the day and an arrival time at the next berth early in the same day. In this case, the day of arrival was increased by one day to account for the change past midnight. In some cases the error was due to an empty field.

Electronic data available from the MEPA included foreign vessels only and did not include Jones Act (domestic flag) vessels. No record is kept of the individual vessels or destinations for domestic flag ships, but the number of inbound and outbound vessels with draft are available on a per month basis. Table 6-5 presents this data summary. These domestic vessels represent less than 10% of the total Lower Mississippi River traffic.

Table 6-5. Jones Act (Domestic Flag) vessel entrances and clearances for the Lower Mississippi River as provided by the New Orleans MEPA for 1996

Entrance Month	Total Vessels	Total Draft	Clearance Month	Total Vessels	Total Draft
January	37	746	January	39	1,139
February	40	797	February	42	1,067
March	43	894	March	39	1,196
April	40	857	April	46	1,361
May	41	923	May	45	1,374
June	39	869	June	40	1,184
July	40	782	July	44	1,262
August	45	940	August	49	1,377
September	39	781	September	42	1,169
October	41	912	October	44	1,266
November	38	833	November	33	993
December	37	837	December	37	1,153
Total	**480**	**10,171**	**Total**	**500**	**24,712**

If a date field was empty and an accurate guess could be made to the date, a date was entered. If a time was missing, the estimated time of arrival or departure was used rather than the actual date or time. If these estimated times were not available, the record was excluded from the time-in-mode calculations, but its ship-type characteristics were still included in those averages in Table 6-6. Therefore, for some time-in-mode or ship-type characteristic fields in Table 6-6 there is an entry of ND meaning that no data were available. If a significant number of time-in-modes were encountering similar errors, the pilot's association of the MEPA was contacted to get information on why these calculations might be incorrect.

Tug assistance will affect the time-in-mode for a vessel. A vessel coming to anchor will not require tug assistance. A dry-cargo vessel docking at a berth will virtually always require tug assistance and will meet the tug at the entrance to the port area. All vessels are under their own power even when docking with tug assistance. The main propulsion engines may be in neutral during the final stages of docking, but they are not shut down until the vessel is secured at the dock or anchorage.

Speeds in the river and average time between docks is affected by the current in the River. The current is seasonal and is usually strongest at high water in April and weakest during low water in October. Currents can be strong in the passes and vary from 0 to 4 knots for the Southwest Pass and 0.4 to 2 knots for South Pass depending on the time of year. More detail on the River, major ports, pilot's associations, and current are available in Appendix B.1.

Table 6-6: Summary of 1996 Deep-Sea Vessel Data for the Lower Mississippi River

Ship Type	Engine Type	DWT Range	Calls	Shift	DWT (Tonnes)	Power (hp)	Vessel Speed (knots)	Engine Speed (RPM)	% RPM >130	Date of Build	Cruise (hr/call)	RSZ (hr/call)	Maneuver (hr/call)	Hotel (hr/call)
BARGE CARRIER	2	35,000 - 45,000	9	2	44,799	26,100	18	ND	ND	1972	2.8	18.3	1.7	80.1
		> 45,000	10	1	49,835	26,000	18	ND	ND	1969	2.8	18.6	1.6	81.4
	Steam Turbine	35,000 - 45,000	10	2	41,578	31,565	22	ND	ND	1974	2.3	18.2	1.8	107.7
		> 45,000	6	2	47,036	31,565	22	ND	ND	1975	2.3	18.8	1.9	76.7
	ND	ND	3	3	ND	ND	ND	ND	ND	ND	2.3	19.9	2.5	134.0
BARGE CARRIER Total			**38**	**10**	**45,701**	**28,570**	**20**	**ND**	**ND**	**1972**	**2.5**	**18.6**	**1.8**	**91.4**
BULK CARRIER	2	<25,000	438	373	18,138	8,060	15	140	39%	1979	3.4	20.7	2.4	144.7
		25,000 - 35,000	717	649	29,492	10,768	15	132	51%	1978	3.3	19.9	2.5	172.9
		35,000 - 45,000	507	436	39,596	11,266	15	114	15%	1982	3.4	20.8	2.5	153.8
		> 45,000	1,183	1,108	72,142	14,501	15	98	0%	1984	7.8	18.4	2.7	195.2
	4	<25,000	70	60	15,614	6,606	14	479	100%	1975	3.5	21.7	2.4	124.7
		25,000 - 35,000	13	13	27,092	9,528	14	278	100%	1987	3.5	21.5	2.6	193.2
		35,000 - 45,000	10	9	38,731	12,650	16	464	100%	1981	3.3	21.6	2.7	252.9
		> 45,000	26	24	63,419	13,531	14	342	73%	1983	3.5	16.9	2.8	200.2
	Steam Turbine	<25,000	5	2	18,314	8,384	15	ND	ND	1975	5.0	14.1	1.9	81.7
		25,000 - 35,000	1	1	33,373	11,837	15	ND	ND	1983	3.3	35.1	2.5	38.7
		> 45,000	21	20	54,624	17,614	18	ND	ND	1970	2.9	16.2	2.7	198.4
	ND	ND	10	10	ND	ND	ND	ND	ND	ND	3.7	20.4	2.5	206.7
BULK CARRIER Total			**3,001**	**2,705**	**46,560**	**11,904**	**15**	**123**	**21%**	**1981**	**5.1**	**19.6**	**2.6**	**173.9**
CONTAINER SHIP	2	<25,000	120	23	18,707	15,717	19	117	27%	1987	2.7	14.6	1.7	58.4
		25,000 - 35,000	6	2	28,019	19,411	19	111	0%	1984	2.8	14.5	2.0	66.6
		35,000 - 45,000	66	18	38,743	27,387	21	91	0%	1987	2.5	12.9	1.8	25.5
		> 45,000	4	1	53,726	28,845	19	97	0%	1985	3.1	13.1	1.8	30.0
	4	<25,000	84	10	10,063	12,157	17	425	100%	1991	2.8	12.8	1.6	20.5
	Steam Turbine	<25,000	58	11	21,711	25,280	22	ND	ND	1974	2.3	12.4	1.7	28.7
		25,000 - 35,000	37	3	26,803	32,787	22	ND	ND	1974	2.3	12.8	1.6	31.8
		35,000 - 45,000	1	ND	38,656	31,565	21	ND	ND	1971	2.3	18.5	1.5	250.8
	ND	ND	3	3	ND	ND	ND	ND	ND	ND	3.5	12.7	2.8	190.0
CONTAINER SHIP Total			**379**	**71**	**22,127**	**20,366**	**20**	**242**	**53%**	**1984**	**2.6**	**13.4**	**1.7**	**38.6**
GENERAL CARGO	2	<15,000	247	156	9,246	6,166	15	178	91%	1981	3.5	19.9	2.2	141.7
		15,000 - 30,000	265	114	20,223	11,344	16	134	30%	1982	3.1	19.0	2.0	88.4
		30,000 - 45,000	41	23	40,358	12,943	15	97	0%	1983	3.3	22.9	2.2	84.2
		> 45,000	4	1	46,648	14,313	17	105	0%	1995	3.0	13.9	1.9	32.8
	4	<15,000	308	186	5,180	3,047	12	493	100%	1979	4.1	20.2	2.2	193.2
		15,000 - 30,000	43	28	18,775	8,922	15	460	100%	1979	3.3	21.1	2.2	138.1
	Steam Turbine	15,000 - 30,000	2	2	22,536	23,673	21	ND	ND	1969	3.0	16.8	3.0	230.8
	ND	ND	1	1	ND	ND	ND	ND	ND	ND	ND	15.2	2.5	24.9
GENERAL CARGO Total			**911**	**511**	**13,112**	**7,128**	**15**	**212**	**64%**	**1980**	**3.6**	**19.9**	**2.1**	**140.4**
MISCELLANEOUS	2	<1500	1	1	879	3,000	12	ND	ND	1978	ND	36.8	2.5	1276.3
		> 4,500	1	ND	9,360	10,330	18	ND	ND	ND	2.8	19.7	1.5	1072.3
	4	<1500	11	5	878	3,478	14	ND	ND	1980	3.9	11.4	2.0	502.4
		> 4,500	1	ND	9,950	13,800	15	ND	ND	1982	3.3	13.0	1.5	234.7
	ND	ND	7	7	ND	ND	ND	ND	ND	ND	5.0	17.2	2.7	355.5
MISCELLANEOUS Total			**21**	**13**	**2,132**	**4,670**	**14**	**ND**	**ND**	**1980**	**4.2**	**14.9**	**2.2**	**512.1**

Table 6-6: Summary of 1996 Deep-Sea Vessel Data for the Lower Mississippi River

Ship Type	Engine Type	DWT Range	Calls	Shift	DWT (Tonnes)	Power (hp)	Vessel Speed (knots)	Engine Speed (RPM)	% RPM >130	Date of Build	Cruise (hr/call)	RSZ (hr/call)	Maneuver (hr/call)	Hotel (hr/call)
PASSENGER	2	<5,000	26	4	4,217	29,370	21	ND	ND	1983	2.4	18.7	1.7	25.5
		5,000 - 10,000	54	ND	6,473	30,083	19	ND	ND	1985	2.6	18.7	1.5	16.9
		> 15,000	9	ND	19,830	14,726	18	102	0%	1988	2.8	11.5	1.6	36.1
	4	<5,000	4	1	1,358	9,167	17	750	100%	1967	3.1	18.5	1.9	188.5
		5,000 - 10,000	7	1	6,620	36,706	20	533	100%	1991	2.6	18.7	1.6	26.7
	Steam Turbine	5,000 - 10,000	52	1	8,721	25,504	23	ND	ND	1958	2.4	18.5	1.5	20.3
PASSENGER Total			**152**	**7**	**7,519**	**27,240**	**21**	**363**	**53%**	**1976**	**2.5**	**18.2**	**1.6**	**25.7**
REEFER	2	5,000 - 10,000	5	2	8,467	10,440	18	141	50%	1982	2.9	16.3	1.9	251.1
		10,000 - 15,000	8	1	11,457	14,812	20	123	0%	1980	2.6	18.1	1.6	383.5
	4	<5,000	1	1	4,196	4,400	15	ND	ND	1981	3.3	10.9	3.0	186.9
REEFER Total			**14**	**4**	**9,871**	**12,507**	**19**	**128**	**14%**	**1980**	**2.8**	**17.0**	**1.8**	**322.2**
RORO	2	<5,000	4	ND	4,613	6,100	17	ND	ND	1979	3.0	19.4	1.5	89.4
		5,000 - 10,000	7	3	6,521	7,014	17	ND	ND	1983	3.0	19.2	1.9	120.7
		10,000 - 15,000	10	5	12,777	11,512	17	157	100%	1989	3.0	16.6	2.1	192.2
		> 15,000	45	12	37,027	27,881	19	102	0%	1982	2.8	19.7	1.8	44.9
	4	<5,000	8	5	3,262	3,336	12	1800	100%	1980	4.0	18.4	2.2	101.7
		5,000 - 10,000	26	8	9,883	5,998	14	500	100%	1984	3.4	13.0	1.8	25.5
RORO Total			**100**	**33**	**21,412**	**16,259**	**17**	**451**	**86%**	**1983**	**3.1**	**17.5**	**1.8**	**66.2**
TANKER	2	<30,000	314	292	16,943	7,930	15	168	76%	1984	3.4	25.9	2.5	81.8
		30,000 - 60,000	304	254	40,559	12,593	15	111	2%	1984	3.3	21.7	2.5	91.6
		60,000 - 90,000	303	271	77,606	15,455	15	97	0%	1984	3.4	27.0	2.4	71.0
		90,000 - 120,000	287	237	97,851	15,067	15	95	0%	1990	3.4	27.5	2.4	66.6
		120,000 - 150,000	49	18	134,806	23,453	15	99	0%	1983	3.3	10.4	1.9	76.3
		> 150,000	4	4	157,345	19,605	14	85	0%	1992	3.5	19.8	2.5	107.7
	4	<30,000	103	93	9,575	5,240	14	414	74%	1981	3.7	23.1	2.6	79.8
		30,000 - 60,000	19	18	46,237	15,072	16	ND	ND	1979	3.2	25.2	2.6	454.9
		60,000 - 90,000	53	46	81,275	14,394	15	296	58%	1982	3.4	25.3	2.4	66.2
	Steam Turbine	30,000 - 60,000	10	10	40,102	15,190	16	ND	ND	1967	3.2	25.7	2.7	96.0
		60,000 - 90,000	3	2	71,694	19,728	16	ND	ND	1971	3.1	14.0	2.3	73.9
		90,000 - 120,000	3	3	92,809	24,167	16	ND	ND	1977	3.0	26.6	2.7	73.1
		120,000 - 150,000	1	1	122,249	25,647	16	ND	ND	1973	3.1	29.0	2.5	134.5
	ND	ND	5	5	ND	ND	ND	ND	ND	ND	ND	16.5	2.5	143.7
TANKER Total			**1,458**	**1,254**	**57,586**	**12,699**	**15**	**132**	**20%**	**1985**	**3.4**	**24.7**	**2.4**	**83.0**
TUG	2	< 1,000	3	2	669	6,717	15	ND	ND	1978	3.4	18.4	2.2	280.2
		< 500	28	24	6	3,631	12	ND	ND	1970	4.3	18.7	2.5	558.6
	4	< 500	4	4	0	3,628	ND	ND	ND	1966	3.9	17.7	2.8	1420.6
	ND	ND	44	44	ND	ND	ND	ND	ND	ND	4.0	14.1	2.6	847.7
TUG Total			**79**	**74**	**62**	**3,895**	**13**	**ND**	**ND**	**1970**	**4.1**	**16.1**	**2.6**	**752.7**
VEHICLE CARRIER	2	> 35,000	2	2	40,999	14,000	15	ND	ND	ND	3.3	26.4	2.5	117.3
VEHICLE CARRIER Total			**2**	**2**	**40,999**	**14,000**	**15**	**ND**	**ND**	**ND**	**3.3**	**26.4**	**2.5**	**117.3**
Grand Total			**6,155**	**4,684**	**40,829**	**12,393**	**15**	**154**	**30%**	**1982**	**4.2**	**20.3**	**2.4**	**142.1**

SECTION 7
CONSOLIDATED PORT OF NEW YORK AND PORTS ON THE HUDSON RIVER INCLUDING ALBANY, NY

7.1 DATA

Data were received from the MEPA of the Port of New York (Reference 7-1) for all commercial vessels that called in the waterways covered by the MEPA for calendar year 1996. Assistance on time-in-mode and normal vessel operations was received from pilots at the Sandy Hook Pilot's Association (Reference 7-2). Ports and anchorages covered in the dataset range from the New Jersey Intracoastal Waterway in the southwest, to ports on the Hudson up to Albany in the north, and to the Long Island Sound in the northwest. The majority of vessels enter and exit through the Lower New York Bay and pick up a pilot at Ambrose. A smaller but significant number of vessels enter or exit through the Long Island Sound picking up the pilot at City Island.

USACE port/waterways included in the MEPA data are listed in Table 7-1.These ports and waterways are those that reported vessel traffic in 1995. The following port/waterways may also be within the region reported by the MEPA. Peekskill Harbor, NY; Saugerties Harbor, NY; Hudson River, NY; Deepwater in Upper Bay, NYC to Waterford, NY; Hudson River, NY, Mouth of Spuyten Duyvil Creek to Water; New Jersey Intracoastal Waterway; and Hudson River Channel, NY and NJ. These port/waterways are not included in Table 7-1 because they had no reported commercial marine traffic in 1995.

Table 7-1. Typical Ports within the MEPA of the Port of New York dataset which had USACE vessel trips reported for 1995

DSP Rank	Typical Port	USACE Port Code
3	Port of New York (Consolidated Statement of Waterborne Commerce)	398
50	Port of Albany, NY	505
NA	Tarrytown Harbor, NY	501
NA	Rondout Harbor, NY	503

The traffic recorded by and attributed to the Port of New York and the various ports on the Hudson River may be defined differently by different organizations such as the USACE and the MEPA. For instance, the MEPA data does not include vessels calling on ports on Long Island, thus none of the Long Island port/waterways are included in Table 7-1 or the trip totals in Table 7-3. More detailed port information is available in Appendix B.2.

The dataset received from the MEPA contains the information on the vessel name, ship-type, and flag; date, time, and location of the pilot's boarding; location of the first berth and subsequent berths; date and time during shift to other berths, and other information as shown in Appendix A, Table A-5. The MEPA data did not include specific arrival dates and times for the first, or any subsequent, berths .

Data received from the MEPA had LRNs for most of the ships. Out of 4,636 records, 4,371 had valid LRNs. The remaining ships were matched with LRNs by comparing ship name, ship-type, and DWT provided by the MEPA with LMIS data. If no LRN was available for a ship name identical to the one in the MEPA database, a similar ship name with the same ship-type and similar DWT was selected. The use of ship-type and DWT categories in the summary tables provide enough leeway to reduce the impact of small errors in the matching process. Each record represents a total call on the Port of New York and associated waterways. A call is one entrance and one exit from the entire MEPA Area reported by the MEPA of the Port of New York. Table 7-5, located at the end of this section, is a summary table of all the vessels recorded by the MEPA in 1996 presented by ship-type, engine type, and DWT range. Ship-types were those given in the Lloyds data except that similar categories were grouped together for simplicity. Table 7-2 gives the number of calls per ship-type for calendar year 1996.

Table 7-2. Calls and shifts by ship-type as recorded by the MEPA of the Consolidated Port of New York

Ship-Type	Calls	Shifts	% of dry-cargo calls [a]
BARGE CARRIER	6	3	NA
BULK CARRIER	390	400	11.5%
CONTAINER SHIP	1,820	146	53.5%
GENERAL CARGO	326	86	9.6%
MISCELLANEOUS	23	11	NA
PASSENGER	227	6	6.7%
REEFER	64	4	1.9%
RORO	224	100	6.6%
TANKER	1,203	1,505	NA
VEHICLES CARRIER	349	151	10.2%
Grand Total	**4,632**	**2,412**	**100.0%**

[a] % of dry-cargo calls excludes calls from barge carrier, miscellaneous, and tanker ship-types

Some vessel types are rarely, if ever, reported by the MEPA. These vessels include ferries, tugs, barges, supply vessels, yachts, fishing vessels, and excursion vessels. There are a few fishing and cable-layer vessels in the database that could be useful in developing default characteristics and actions of these types of vessels. However, as these vessel types are not completely recorded, we have grouped them together in a "miscellaneous" category.

Table 7-3 presents a summary of trips for the USACE waterway codes that are included in the MEPA of the

Port of New York database by ship-type. There is some discrepancy in ship-types between the USACE and the MEPA matches with LMIS. Fishing vessels are not a separate category recognized by the USACE. The "miscellaneous" vessels in the MEPA database may correspond with some of the "other" vessels in the USACE database, but more data is needed before emissions can be estimated for the vessels in these categories. The totals in Table 7-3 should be used with the methodology in Section 4 to calculate calls by ship-type for each Typical Port within the MEPA Area.

Table 7-3. USACE Trips by ship-type for each Typical Port within the MEPA of the Port of New York dataset

Typical Port		Ship-Type [a, c]									Total Trips
Rank	Name	BC	CS	GC	PA	RF	RO	TA	VC	UC	
3	Port of New York	453	3,202	722	243	108	611	3,218	407	1,523	10,487
50	Port of Albany	97	5	16	1	0	8	175	0	55	357
Total		550	3,207	738	244	108	619	3,393	407	1,578	10,844

[a] BC = Bulk Carrier, CS = Container Ship, GC = General Cargo, PA = Passenger, RF = Reefer, RO = RORO, TA = Tanker, VC = Vehicle Carrier, UC = Unspecified Dry-cargo,
[b] USACE Port/waterways 501 and 503 had barge and tug traffic only
[c] Trip totals do not include intraport movements (vessel movements within the same USACE port/waterway)

For purposes of determining MEPA calls for each Typical Port, we suggest allocating the UC trips over the other dry-cargo ship-types using the percent of dry-cargo calls presented in Table 7-2. For example, Port 3, the Port of New York, has 1,523 UC trips. According to Table 7-2, BC trips are 11.5% of the dry-cargo calls for the entire MEPA Area, and 11.5% of 1,523 is 175. Thus the total revised BC trips for the Port of New York would be 453 plus 175 or 628 trips. This same process should be followed for all the ship-types and all the other Typical Ports within the MEPA Area. This method of allocating the undefined ship-type trips is the default method. Any data available from the port or other reliable source that indicates a more refined allocation of UC ship-types trips should be used in place of the above method..

7.2 TIME-IN-MODE CALCULATIONS

7.2.1 Cruise

Cruise speed is the average continuous speed of the vessel in open water. Cruise is treated as beginning twenty-five miles out from the point of picking up the pilot at Ambrose or City Island. It is important to note that there are periods of acceleration and deceleration within each time-in-mode. Cruise is also allocated to the port for 25 miles from the departing pilot station. The cruise times for each call were determine using Equation 7.1.

Cruise = 25 / [Vessel Speed (knots)] * 2 **(7.1)**

7.2.2 Reduced Speed Zone

Reduced speed zone (RSZ) time is the time the vessel is at a speed less than full cruise and greater than the 4 knot average used for maneuvering. Vessels begin to slow approximately 10 miles before they pick up the pilot and accelerate back to a speed of 10 to 16 knots until the Narrows Bridge where they slow again. Average speeds are assumed as follows based upon conversations with the pilots: service speed to the pilotage then reduce to 12 knots for 15 miles to the Narrows Bridge. The average vessel speed from the Narrows Bridge to Manhattan in the Hudson is 10 knots, the average speed in the East River is 7 knots, the average vessel speed in the Kill van Kull River is 6 knots, and the average vessel speed in the Arthur Kill River is 5 knots. These average speeds are adjusted for two ship-types. The direction of the tide has a large affect upon the pilots decisions on when and how much to reduce speeds. For sharp turns, most vessels will come to dead slow speed of 4 knots, but again, this is based at the discretion of the pilot and based on draft and length of the vessel as well as weather, currents, and tide. Neither tide nor sharp turns are explicitly taken into account in our time-in-mode calculations, but the pilots did give us average times based on their experience.

There are a multitude of ports within the Consolidated Port of New York. The distances and times to each port listed in Table 7-4 were determined from conversations with the Sandy Hook Pilots. These average times were used as to calculate RSZ times from Ambrose to ports in the vicinity of the port areas listed in Table 7-4. The times in Table 7-4 are combined RSZ and maneuvering. Maneuvering is assumed to be 0.7 hours for each port and 0.3 for each anchorage. Depending on whether the first berth in the database was located closer to Ambrose than the port area in Table 7-4, right in the middle of the area in Table 7-4, or further away from Ambrose than the port area in Table 7-4, an average time at the low, average, or high end of the "Average Time" was used for the RSZ for that berth. Shift contribution to RSZ time is calculated using the same general port areas. If the estimated time between berths for a shift is less than 0.6 hours, all of the shifting time is allocated to maneuvering.

A correction was also made for the maneuverability differences of general ship-types. Container ships are typically more maneuverable and faster than other dry-cargo ships; tankers are usually more unwieldy and slower than other cargo ships, especially when maneuvering in congested port areas. These two variables were factored into the average time-in-modes by taking the calculated RSZ and maneuvering times and multiplying them by 0.8 for container ships and by 1.2 for tanker vessels. Bulk carrier, general cargo, and the remaining dry-cargo ship-types were calculated at the times listed in Table 7-4.

Table 7-4. Average time, distance, and speed from the pilot's station to maneuver into docks in specific port areas.

Port Areas	From Ambrose (nautical miles)	Average Time (hr)
Verrazano Narrows Bridge (Upper Bay)	11	1 - 1.5
Tosco Bayway, (Most points on Kill Van Kull and Arthur Kill)	21	2 - 3
Port Elizabeth and Port Newark (Newark Bay)	20	3 - 4
Perth Amboy	18	2-3
Execution Rocks (Long Island Sound)	38	3 - 3.5
George Washington Bridge (Hudson North of Manhattan)	27	2.5 - 3
Albany (North Hudson)	140	15 - 19

7.2.3 Maneuvering

On the average, maneuvering starts two nautical miles from the dock and continues until the vessel is tied up. The harbor pilots suggested that a fairly accurate number to use for average maneuvering speed into the dock was 3 knots starting two miles from the dock. This is repeated as the vessel is leaving the port for an average time-in-mode per call of 1.3 hour. Anchorages take less maneuvering time and are allotted 0.3 hours in and 0.3 hours out for a total time in mode per anchorage of 0.6 hours. Time-in-mode for shifts is allotted partially to maneuvering and partially to RSZ except for shifts between ports that are within 6 miles of each other, which are considered as maneuvering time only.

7.2.4 Hotelling

Hotelling occurs when the vessel is at anchorage or at a berth and is the total time in port minus the time-in-mode for RSZ and maneuvering.

Hotel (hr/call) = (DTE_DATE - ARR_DATE)*24 + (DepT - ArrT) - Maneuver - RSZ (7.2)

Where:
- DTE_DATE = the date of departure from the Consolidated Port of New York
- ARR_DATE = the arrival date for the Consolidated Port of New York
- DepT = either OUT_AMBR, the time of departure from Ambrose, or OUT_CTYIS, the time of departure from City Island
- ArrT = either the AMB_TIME, the time of arrival at Ambrose, or CTYIS_TIME, the time of arrival at City Island

and "maneuver" and "RSZ" are as defined previously in this section.

7.2.5 Summary Table

The summary table, Table 7-5 reflects all of the ship-types, vessel characteristics, and time-in-mode data available for the Consolidated Port of New York and Albany, NY. There are some ship-type categories for which one or more of the data fields had no available data. This is most commonly seen in "Engine Speed" as this was one of the least complete LMIS data fields. Steam turbines do not have engine speed recorded in the LMIS data. There is a large standard deviation for many of the hotelling totals as a few vessels that stayed in port for repairs, retrofit or some other reason had hotelling times in the hundreds or thousands of hours. If one of these long hotelling times occurs for a ship-type category that only have a few calls, the average hotelling time will appear much higher than may actually be typical. In these cases, we recommend using the average hotelling time for the entire ship-type.

7.3 DATA QUALIFIERS

Many fields did not have data for all records but the most important fields showing dates, times, ship-type, and ship name were more complete. After calculating RSZ, maneuvering, and hotelling times for each call and shift, a visual inspection of the results was performed. Data that had negative times or excessively large times for any of the time-in-modes were examined for obvious inconsistencies. If an obvious inconsistency was found such as an arrival or departure date with a year other than 1996 (or in some very few cases, January of 1997) the year was changed to the appropriate year. Another somewhat common error would be a departure time late in the day and an arrival time at the next berth early in the same day. In this case, the day of arrival was increased by one day to account for the change past midnight. In some cases the error was due to an empty field.

If a date field was empty and an accurate guess could be made to the date, a date was entered. If a time was missing, the estimated time of arrival or departure was used rather than the actual date or time. If these estimated times were not available, the record was excluded from the time-in-mode calculations, but its ship-type characteristics were still included in those averages in Table 7-5. Therefore, for some time-in-mode or ship-type characteristic fields in Table 7-5 there is an entry of ND meaning that no data were available. If a significant number of time-in-modes were encountering similar errors, the pilot's association of MEPA was contacted to get information on why these calculations might be incorrect.

Tug assistance will affect the time-in-mode for a vessel. A vessel coming to anchor will not require tug assistance. A dry-cargo vessel docking at a berth will virtually always require tug assistance and will meet the tug approximately two miles from the destination berth. All vessels are under their own power even when docking with tug assistance. The main propulsion engines may be in neutral during the final stages of docking, but they are not shut down until the vessel is secured at the dock or anchorage.

Table 7-5: Summary of 1996 Deep-Sea Vessel Data for the Consolidated Port of New York and Ports on the Hudson River

Ship Type	Stroke	DWT Category	Calls	Shifts	DWT (tonnes)	Power (hp)	Vessel Speed (knots)	Engine Speed (RPM)	%RPM >130	Date of Build	Cruise (hr/call)	RSZ (hr)	Man. (hr)	Hotel (hr)
BARGE CARRIER	Steam	35,000 - 45,000	6	3	46,153	31,541	22	ND	ND	1974	2.3	3.4	1.6	209.4
BARGE CARRIER Total			**6**	**3**	**46,153**	**31,541**	**22**	**ND**	**ND**	**1974**	**2.3**	**3.4**	**1.6**	**209.4**
BULK CARRIER	2	<25,000	69	47	19,957	8,666	15	152	62%	1982	3.3	14.3	2.2	120.0
		25,000 - 35,000	85	80	29,401	10,766	15	130	63%	1979	3.3	11.6	2.6	184.6
		35,000 - 45,000	64	56	39,241	10,891	15	118	10%	1982	3.4	14.8	2.4	102.0
		> 45,000	122	177	71,583	14,107	14	102	0%	1986	3.5	5.9	2.9	115.6
	4	<25,000	16	16	18,260	6,523	15	573	100%	1979	3.4	7.3	2.7	219.2
		25,000 - 35,000	1	0	25,739	8,200	14	157	100%	1992	3.6	4.9	1.3	104.4
		35,000 - 45,000	1	2	41,513	10,000	14	ND	ND	1982	3.6	2.4	5.0	226.2
		> 45,000	4	5	70,719	12,075	14	ND	ND	1980	3.6	4.6	2.5	83.1
	Steam	<25,000	28	17	18,314	8,378	15	ND	ND	1975	3.3	5.6	1.3	39.9
BULK CARRIER Total			**390**	**400**	**41,733**	**11,119**	**15**	**132**	**24%**	**1982**	**3.4**	**10.1**	**2.5**	**127.5**
CONTAINER SHIP	2	<25,000	396	63	20,258	16,922	19	117	10%	1987	2.7	4.2	1.2	24.9
		25,000 - 35,000	167	21	30,162	22,994	20	102	0%	1984	2.6	4.1	1.2	22.3
		35,000 - 45,000	348	26	40,772	40,589	23	99	0%	1982	2.2	4.2	1.1	19.7
		> 45,000	491	18	51,853	38,622	22	95	0%	1988	2.3	4.2	1.1	22.2
	4	<25,000	92	5	9,833	8,018	17	481	100%	1989	3.0	4.2	1.1	22.1
		25,000 - 35,000	5	1	27,396	15,962	18	386	100%	1980	2.7	4.0	1.4	16.0
		> 45,000	24	2	62,685	50,235	24	99	0%	1993	2.1	4.2	1.1	31.0
	Steam	<25,000	234	8	20,521	25,642	22	ND	ND	1971	2.3	4.1	1.1	25.5
		25,000 - 35,000	33	2	26,207	31,541	22	ND	ND	1973	2.3	4.2	1.1	20.5
		35,000 - 45,000	14	0	39,433	35,483	25	ND	ND	1976	2.0	4.1	1.1	15.7
		> 45,000	16	0	47,864	79,967	23	ND	ND	1973	2.2	4.2	1.1	16.2
CONTAINER SHIP Total			**1,820**	**146**	**34,197**	**29,929**	**21**	**131**	**10%**	**1984**	**2.4**	**4.2**	**1.1**	**22.7**
GENERAL CARGO	2	<15,000	49	19	11,029	7,586	16	146	25%	1986	3.2	4.3	1.9	70.3
		15,000 - 30,000	122	32	20,397	13,611	17	132	32%	1982	2.9	6.5	1.7	54.6
		30,000 - 45,000	54	5	39,365	13,689	15	ND	ND	1981	3.2	4.7	1.5	21.1
		> 45,000	2	1	46,865	10,345	15	111	0%	1993	3.3	4.5	2.1	29.7
	4	<15,000	79	25	5,539	3,765	13	616	100%	1987	3.9	7.0	1.7	78.9
		15,000 - 30,000	11	4	19,019	8,896	17	ND	ND	1982	3.0	7.6	1.9	124.3
	Steam	<15,000	9	0	12,931	14,746	19	ND	ND	1962	2.6	4.0	1.3	1060.7
GENERAL CARGO Total			**326**	**86**	**18,440**	**10,184**	**16**	**336**	**58%**	**1983**	**3.3**	**5.9**	**1.7**	**81.4**
MISCELLANEOUS	2	<1500	2	5	24,713	2,200	12	ND	ND	1968	4.2	21.1	4.3	146.4
		> 4,500	2	2	23,945	9,000	16	ND	ND	1987	3.1	5.2	2.3	77.6
	4	<1500	18	4	11,783	2,320	14	ND	ND	1987	3.6	4.7	1.6	53.7
		> 4,500	1	0	5,009	13,581	14	720	100%	1992	3.6	2.3	0.5	1.5
MISCELLANEOUS Total			**23**	**11**	**13,670**	**5,860**	**14**	**720**	**100%**	**1985**	**3.6**	**6.1**	**1.9**	**61.5**
PASSENGER	2	<5,000	26	0	4,300	29,370	21	ND	ND	1984	2.4	5.2	1.3	6.3
		5,000 - 10,000	4	0	5,830	19,500	19	ND	ND	1971	2.7	5.2	1.3	15.6
	4	<5,000	22	3	1,896	15,080	18	646	100%	1987	2.9	6.0	1.5	24.1
		5,000 - 10,000	97	3	6,467	21,809	19	588	100%	1974	2.7	5.2	1.4	8.8
		10,000 - 15,000	1	0	8,600	86,140	18	514	100%	1996	2.8	5.2	1.3	72.1
		> 15,000	19	0	15,521	130,005	28	ND	ND	1969	1.8	5.2	1.3	8.1
	Steam	5,000 - 10,000	14	0	9,102	41,479	25	ND	ND	1963	2.0	5.2	1.3	10.5
		10,000 - 15,000	1	0	13,960	40,177	18	ND	ND	1961	2.8	5.2	1.3	6.2
		> 15,000	43	0	16,604	43,369	24	ND	ND	1961	2.1	5.1	1.3	7.8
PASSENGER Total			**227**	**6**	**8,648**	**36,700**	**21**	**600**	**100%**	**1973**	**2.4**	**5.2**	**1.4**	**10.2**
REEFER	2	5,000 - 10,000	3	0	9,864	14,865	22	ND	ND	1980	2.3	4.7	0.8	24.9
		10,000 - 15,000	60	4	11,757	16,661	22	114	0%	1988	2.3	4.4	1.2	36.9
		> 15,000	1	0	15,100	20,500	22	ND	ND	1979	2.3	4.7	0.5	8.2

Table 7-5: Summary of 1996 Deep-Sea Vessel Data for the Consolidated Port of New York and Ports on the Hudson River

Ship Type	Stroke	DWT Category	Calls	Shifts	DWT (tonnes)	Power (hp)	Vessel Speed (knots)	Engine Speed (RPM)	%RPM >130	Date of Build	Cruise (hr/call)	RSZ (hr)	Man. (hr)	Hotel (hr)
REEFER Total			**64**	**4**	**11,721**	**16,637**	**22**	**114**	**0%**	**1987**	**2.3**	**4.4**	**1.1**	**35.8**
RORO	2	<10,000	73	25	16,968	11,478	17	97	0%	1981	3.0	4.4	1.8	28.2
		10,000 - 20,000	13	3	15,302	11,338	16	159	100%	1990	3.1	4.5	1.7	25.5
		20,000 - 30,000	3	5	23,242	20,271	19	ND	ND	1981	2.6	4.2	4.1	277.1
		> 30,000	119	59	46,217	25,750	19	97	0%	1983	2.7	4.7	2.1	17.0
	4	<10,000	14	7	5,979	7,851	15	425	100%	1977	3.3	7.5	2.0	93.7
		20,000 - 30,000	1	0	20,303	25,920	19	ND	ND	1971	2.6	4.0	1.3	1490.5
	Steam	10,000 - 20,000	1	1	15,946	29,570	24	ND	ND	1970	2.1	3.2	3.2	1625.7
RORO Total			**224**	**100**	**31,817**	**19,088**	**18**	**104**	**3%**	**1982**	**2.9**	**4.7**	**2.0**	**43.2**
TANKER	2	<30,000	202	230	22,271	8,766	15	135	27%	1985	3.4	6.1	3.4	45.6
		30,000 - 60,000	489	702	34,820	12,546	15	117	7%	1985	3.4	6.3	3.9	61.6
		60,000 - 90,000	155	208	74,752	15,612	15	101	0%	1984	3.3	5.8	3.6	64.5
		90,000 - 120,000	81	81	95,769	13,993	14	98	0%	1991	3.5	6.1	3.2	62.6
		120,000 - 150,000	31	26	140,266	20,709	15	86	0%	1987	3.4	4.4	2.7	72.3
		> 150,000	9	10	137,489	20,940	14	85	0%	1991	3.6	6.3	3.2	72.2
	4	<30,000	65	55	15,402	7,551	15	351	65%	1984	3.4	5.6	3.1	29.5
		30,000 - 60,000	21	23	43,052	14,917	16	ND	ND	1979	3.2	5.5	3.3	57.0
		60,000 - 90,000	29	44	71,780	13,598	14	256	39%	1985	3.5	6.2	3.7	58.8
	Steam	<30,000	14	12	26,459	14,784	18	ND	ND	1964	2.8	5.4	3.2	26.4
		30,000 - 60,000	82	99	36,889	15,108	16	ND	ND	1964	3.1	6.1	3.6	50.1
		60,000 - 90,000	2	3	63,000	19,713	16	ND	ND	1971	3.1	5.6	3.9	85.4
		> 150,000	23	12	35,605	35,293	16	ND	ND	1975	3.1	5.5	2.6	23.8
TANKER Total			**1,203**	**1,505**	**45,538**	**13,120**	**15**	**128**	**12%**	**1983**	**3.4**	**6.0**	**3.6**	**56.0**
VEHICLES CARRIER	2	<12,500	76	17	11,461	11,243	18	119	6%	1982	2.8	5.1	1.6	13.9
		12,500 - 15,000	73	31	13,788	13,961	19	107	0%	1986	2.7	4.9	1.9	17.7
		15,000 - 17,500	72	26	17,041	13,984	18	113	0%	1985	2.7	4.8	1.9	15.7
		> 17,500	54	36	22,727	16,382	19	106	0%	1985	2.6	4.9	2.3	22.9
	4	<12,500	51	32	10,566	13,240	18	518	100%	1980	2.7	5.0	2.2	30.0
		12,500 - 15,000	19	8	13,498	14,287	18	520	100%	1980	2.9	4.9	1.9	24.7
		15,000 - 17,500	2	0	15,396	12,555	18	ND	ND	1982	2.8	4.9	1.3	6.1
		> 17,500	2	1	19,422	16,880	18	ND	ND	1981	2.8	5.1	2.1	6.8
VEHICLES CARRIER Total			**349**	**151**	**14,890**	**13,670**	**18**	**178**	**18%**	**1984**	**2.7**	**4.9**	**2.0**	**19.3**
Grand Total			**4,632**	**2,412**	**33,449**	**20,932**	**18**	**162**	**18%**	**1983**	**2.8**	**5.4**	**2.0**	**45.0**

SECTION 8

PORTS ON THE DELAWARE RIVER INCLUDING PHILADELPHIA, PA

8.1 DATA

Data were received from the Philadelphia MEPA (Reference 8-1) for all commercial vessels that called in the Delaware River from the breakwater to Trenton, NJ for calendar year 1996. Assistance on time-in-mode and normal vessel operations were received from the Philadelphia Pilot's Association (Reference 8-2). Data included in the MEPA database covers deep-sea vessel movements from the Delaware River breakwater to Trenton, NJ. The Delaware River breakwater's approximate location can be found by drawing a line between Cape Henlopen, DE and Cape May, NJ. It is the entrance to the Delaware River.

USACE port/waterways included in the MEPA data are listed in Table 8-1. These ports and waterways are those that reported vessel traffic in 1995. The following port/waterways may also be within the region reported by the MEPA, but were not included in Table 8-1 because they had no reported commercial marine traffic in 1995: Delaware River, NY, NJ, and PA - Mouth of Neversink River; Harbor of Refuge, Delaware Bay, DE; Schuylkill River, PA; Salem River, NJ; Delaware River, Trenton, NJ to the Sea; Delaware River - Philadelphia, PA to breakwater; Delaware River - Philadelphia, PA to Trenton, NJ; Lower Delaware Bay, NJ; and Lower Delaware Bay, DE. More detailed port information on Delaware River Ports can be found in Appendix B.3.

Table 8-1. Typical Ports within the Philadelphia MEPA dataset

DSP Rank	Typical Port	USACE Port Code
17	Philadelphia Harbor, PA	552
18	Marcus Hook, PA	5251
22	Paulsboro, NJ	5252
35	New Castle, DE	299
51	Camden, NJ	551
54	Wilmington, DE	554
73	Chester, PA	297
91	Trenton, NJ	553
NA	Penn Manor, PA	298

The dataset received from the MEPA contains information on the vessel name; ship type; time the vessel entered and cleared the breakwater; anchorage, date at anchor, time at anchor, and time up; dock, dock date, time of first line, and time sailing; shift dock and shift date; estimated and actual times passing Marcus Hook, and other information as shown in Appendix A Table A-6. Data received from the MEPA had LRNs for most of the ships. Out of 2,560 records, 2,123 had valid LRNs. The remaining ships were matched with LRNs by comparing ship name, ship-type, and DWT provided by the MEPA with LMIS data. If no LRN was available for a ship name identical to the one in the MEPA database, a similar ship name with the same ship-type and similar DWT was selected. There is some room for error in this process, but the use of ship-type and DWT categories in the summary tables provides enough leeway to reduce the impact of small errors in the matching process. The 2,560 records define 2,560 calls with shifting details included in each record. A call is one entrance and one exit from the entire area reported by the Philadelphia MEPA.

Table 8-5, located at the end of this section, is a summary table of all the vessels recorded by the MEPA in 1996 presented by ship-type, engine type, and DWT range. Ship-types were those given in the Lloyds data except that similar categories were grouped together for simplicity. Table 8-2 gives the number of calls as recorded by the MEPA per ship-type for calendar year 1996. Some vessel types are rarely, if ever, recorded by the MEPA. These vessels include ferries, tugs, barges, supply vessels, yachts, fishing vessels, and excursion vessels. There are a few fishing vessels in the database that could be useful in developing default characteristics and actions. However, as these vessel types are not completely recorded, they are grouped together in a "miscellaneous" category.

Table 8-2. Calls and shifts by ship-type as recorded by the MEPA for Delaware River Ports

Ship-Type	Calls	Shifts	% of dry-cargo calls [a]
BULK CARRIER	411	377	24.5%
CONTAINER SHIP	398	73	23.7%
GENERAL CARGO	414	291	24.6%
MISCELLANEOUS	12	4	NA
PASSENGER	22	3	1.3%
REEFER	305	157	18.2%
RORO	57	12	3.4%
TANKER	868	1,506	NA
VEHICLE CARRIER	73	15	4.3%
Grand Total	**2,560**	**2,438**	**100.0%**

[a] % of dry-cargo calls excludes calls from miscellaneous and tanker ship-types

Table 8-3 presents a summary of USACE trips for the USACE waterway codes that are included in the Philadelphia MEPA database by ship-type. There is some discrepancy in ship-types between the USACE and the MEPA matches with LMIS. Fishing vessels are not a separate category recognized by the USACE. The "miscellaneous" vessels in the MEPA database may correspond with some of the "other" vessels in the USACE database, but more data is needed before emissions can be estimated for the vessels in these categories. The USACE totals in Table 8-3 can be used with the methodology in Section 4 to create calls by ship-type for each USACE port/waterway.

Table 8-3. USACE trips by ship-type for each USACE port/waterway encompassed by the

Philadelphia MEPA data set

Typical Port		Ship-Type [a]									Total Trips [b]
Rank [c]	Name	BC	CS	GC	PA	RF	RO	TA	VC	UC	
17	Philadelphia, PA	164	230	84	25	87	102	972	31	274	1,969
18	Marcus Hook, PA	17	1	106	8	0	2	641	0	7	782
22	Paulsboro, NJ	5	0	49	2	2	0	630	0	0	688
35	New Castle Area, DE	0	4	24	4	0	0	181	0	2	215
51	Camden, NJ	269	11	66	0	197	18	177	0	162	900
54	Wilmington Harbor, DE	104	163	65	0	174	42	26	113	90	777
73	Chester, PA	17	61	26	0	69	18	10	0	246	447
NA	Penn Manor, PA	0	0	0	0	0	0	11	0	0	11
Ship-Type Totals		**576**	**470**	**420**	**39**	**529**	**182**	**2,648**	**144**	**781**	**5,789**

[a] BC = Bulk Carrier, CS = Container Ship, GC = General Cargo, PA = Passenger, RF = Reefer, RO = RORO, TA = Tanker, VC = Vehicle Carrier, UC = Unspecified Dry-cargo,

[b] Trip totals do not include intraport movements (vessel movements within the same USACE port/waterway)

[c] Trenton, PA (Port #91) reported barge and tug trips only for 1995.

For purposes of determining MEPA calls for each Typical Port, we suggest allocating the UC trips over the dry-cargo ship-types using the percent of dry-cargo calls presented in Table 8-2. For example, Port 51, Camden, NJ, has 162 UC trips. BC trips are 24.5% of the dry-cargo calls for the entire MEPA Area, and 24.5% of 162 is 40. Thus the total revised BC trips for the Camden would be 309 trips. This same process should be followed for all the ship-types for all of the Typical Ports within the MEPA Area. This method of allocating the undefined ship-type trips is the default method. Any data available from the port or other reliable source that indicates a more refined allocation of UC ship-types trips should be used in place of the above method.

8.2 TIME-IN-MODE CALCULATIONS

Average vessel speeds vary widely in the Delaware River and Bay. Vessels begin to slow 5 miles before the breakwater in preparation for picking up the pilot. The vessel will accelerate from the 5-6 knot average used when the pilot is boarding back to a speed of 12-18 knots in the Delaware Bay. Speeds in the Bay depend on ship-type, schedule, weather, traffic, and any intended anchorages. The controlling speed that no vessel may exceed is 20 knots in the River, but few vessels, except container ships and passenger vessels, have service speeds greater than 20 knots, making the limiting factors for speed congestion, schedule, and weather. The current in the Delaware River averages 1.5 knots and will affect the RSZ time. A vessel traveling with the 1.5 knot current will travel an average of 3 knots faster than a similar vessel that enters the River against the current. When possible, pilots time their arrivals and departures in order to use a favorable current.

Based on several conversations with the Philadelphia pilots, the following assumptions on vessel speeds can be made. A vessel will travel at 80-90% of service speed, which ranges from 12 knots for tankers to 18 knots and greater for container ships, after picking up the pilot at the breakwater until reaching either the port of Wilmington or at latest, Marcus Hook. At some point between these two areas, there is often enough traffic that the vessel must slow to 60-70% of service speed, which ranges from 8 knots for tankers to 14 knots for container ships, with periods of much lower speed as the vessel is forced to maneuver. Once the vessel gets within 3-4 miles of its intended berth or anchorage, it will continue at slow or dead-slow speed that usually ranges from 2-6 knots. As the vessel gets closer to the berth, it will continue to slow until it is docking under dead-slow or reverse and is therefore moving at a speed of approximately 4 knots. The propulsion engines continue to run, although they may be idling, until the vessel is secured at the berth or anchorage.

The average times to get to berth or anchorage given in Table 8-2 are based on differences in the time the vessel crosses the breakwater and the time the first line is secured on the vessel or the anchor is lowered. There is a large standard deviation to these average times as would be expected due to the factors given above.

Table 8-4. Average time to get to berth or anchorage for the Ports of the Delaware River

Ports and Anchorages	Nautical miles from Breakwater	Average Time (hr)
Breakwater anchorages/Big Stone Bay	1-5	0.2 - 1
Chesapeake-Delaware Ship Canal (Reedy Point)	41	3.5-4.5
Salem River, NJ	47	3.5 - 4.5
Newcastle, DE	58	3.5 - 4.5
Wilmington, DE	62	4 - 5
Marcus Hook, PA	70	4.5 - 5.5
Paulsboro, NJ	73	5 -6
Philadelphia and Camden	84	6.5 - 8.5
Trenton, NJ	107	10 - 12

Descriptions of time-in-mode are given in Section 3, Table 3-1 of this report. The following descriptions are specific to calculations for Delaware River ports.

8.2.1 Cruise

Cruise speed is the average continuous speed of the vessel in open water. Cruise is treated as beginning twenty-five miles out from the breakwater and is calculated by dividing 25 miles by the service speed of the vessel for both entrances and clearances.

Cruise = 25 / [Vessel Speed (knots)] *2 **(8.1)**

8.2.2 Reduced Speed Zone

Reduced speed zone time or RSZ time is the time the vessel is at a speed less than full cruise and greater than the 4 knot average used for maneuvering. Data from the MEPA contains fields for the time the vessel crosses the breakwater and the time the vessel anchors or secures its first line at dock. These fields were used to determine the RSZ time for vessels in the Delaware River. RSZs were calculated in three pieces for this dataset. RSZin is the time from the breakwater to the first berth minus one hour to account for maneuvering into the berth. RSZin is null for vessels that have inbound anchorages. RSZanchor is the time from the breakwater to the first anchorage. RSZanchor is null for vessels that do not have an anchorage. RSZout is the time from the last berth to the breakwater.

RSZ = RSZin + RSZanchor + RSZout **(8.2)**

RSZin = (DOCKED - ARRIVED) *24 + (DOCK- TIME_BW_CD) - 1 **(8.3)**

RSZanchor = (TIME_ANCHOR - TIME_BW_CD) **(8.4)**

RSZout = (OUT_BW - TIME_BW_CD) * 24 + (SAILED - ARRIVED) **(8.5)**

Where:

DOCKED	= Date vessel docks at first pier
ARRIVED	= Date the vessel arrives at the breakwater
DOCK	= Time the vessel leaves the last berth
TIME_BW_CD	= Time the vessel crosses the breakwater
TIME_ANCHOR	= Time the vessel anchors
OUT_BW	= Time the vessel exits the breakwater
SAILED	= Date the vessel gets underway for the outbound trip

8.2.3 Maneuvering

On the average, maneuvering starts 1-2 nautical miles from the dock and continues until the vessel is tied up. This is repeated as the vessel is leaving the port for an average time-in-mode per call of 1 hour.

Vessel shifts between nearby docks or anchorages usually occur at maneuvering speeds with a 4 knot average. Therefore, vessels that call on more than one berth or anchorage will have longer maneuvering times than would be accounted for by simply taking 1 hour for each berth and 0.5 hour for each anchorage. It is also true that different vessel types maneuver differently. Container ships are generally faster and maneuver in 80% of the time taken by general cargo and bulk carriers. Tankers are generally slower to maneuver and take 20% longer than general cargo and bulk carriers. These percent differences were developed empirically through conversations with the pilots association and the expected times to dock. They will vary between and within ship types and are especially affected by vessel length, breadth, and net tonnage. Those variables were not considered in the time-in-mode calculations for this report.

Maneuvering (hr/call) = 1+ shift(hr) **(8.6)**

Shift (hr) = D/4 (general cargo, bulk carrier, reefer, RORO, vehicle carrier) **(8.7)**

= D/3 (tankers) **(8.8)**

= D/5 (container ships) **(8.9)**

Where:

D = distance between previous berth or anchorage and destination berth or anchorage in nautical miles and the numbers 3, 4, and 5 refer to the expected speed of the vessel in knots for that maneuvering distance.

8.2.4 Hotelling

Hotelling occurs when the vessel is at anchorage or at a berth and is the total time in port minus the time-in-mode for RSZ and maneuvering.

Hotelling (hr/call) = (OUT_BW - TIME_BW_CD) + (SAILED - ARRIVED)* 24
- Maneuver – RSZ **(8.10)**

Variable definitions are as defined previously.

8.3 DATA QUALIFIERS

Many fields did not have data for all records but the most important fields showing dates, times, ship-type, and ship name were more complete than others. After calculating RSZ, maneuvering, and hotelling times for each call and shift, a visual inspection of the results was performed. Data that had negative times or excessively large times for any of the time-in-modes were examined for obvious inconsistencies. If an obvious inconsistency was found, such as an arrival or departure date with a year other than 1996 (or in some very few cases, January of 1997), the year was changed to the appropriate year. Another somewhat common error would be a departure time late in the day and an arrival time at the next berth early in the same day. In this case, the day of arrival was increased by one day to account for the change past midnight. In some cases, the error was due to an empty field.

If a date field was empty and an accurate guess could be made to the date, a date was entered. If a time was missing, the estimated time of arrival or departure was used rather than the actual date or time. If these estimated times were not available, the record was excluded from the time-in-mode calculations, but its ship-type characteristics were still included in those averages in Table 8-5. Therefore, for some time-in-mode or ship-type characteristic fields in Table 8-5 there is an entry of ND meaning that no data were available. If a significant number of time-in-modes were encountering similar errors, the pilot's association or the MEPA was contacted to get information on why these calculations might be incorrect.

Tug assistance will affect the time in mode for a vessel. A dry-cargo vessel docking at a berth will nearly always require tug assistance and will meet the tug at the entrance to the harbor area (Philadelphia, Camden, Wilmington, etc.). Tug assist occurs at dead slow or reverse and is treated at occurring at 4 knots. A vessel coming to anchor will not require tug assistance and is expected to have a maneuvering time of 0.5 hours total for the each anchorage. All vessels are under their own power even when docking with tug assistance. The main propulsion engines may be in neutral during the final stages of docking, but they are not shut down until the vessel is secured at the dock or anchorage.

All vessels in the MEPA dataset entered the Delaware River from the breakwater at the Delaware Capes. The Chesapeake-Delaware Ship Canal (C&D Canal) is another possible entrance. The MEPA estimates that no more than 10% of the vessel traffic for the River enters or exits through the C&D Canal. No correction factors were applied to the data in Table 8-5 to account for this extra vessel traffic.

Data from the Baltimore MEPA has 22 to 30% of the vessels calling on Baltimore Harbor, or approximately 500 vessels, entering or clearing the C&D Canal. That is approximately 20% of the total vessel traffic in the Delaware River and its omission could have a significant effect or air estimate emissions.

Table 8-5: Summary of 1996 Deep-Sea Vessel Data for the Delaware River Ports Including Philadelphia, PA

Ship Type	Engine Type	DWT Range	Calls	Shifts	DWT (tonnes)	Power (HP)	Vessel Speed (knots)	Engine Speed (RPM)	%RPM >130	Date of Build	Cruise (hr/call)	RSZ (hr/call)	Maneuver (hr/call)	Hotel (hr/call)
BULK CARRIER	2	<25,000	109	107	18,365	9,665	14	144	68%	1981	3.5	14.9	1.8	81.0
		25,000 - 35,000	126	112	29,721	9,696	15	126	52%	1982	3.4	14.7	1.7	100.8
		35,000 - 45,000	77	72	38,659	10,320	14	113	11%	1983	3.5	15.2	1.8	95.1
		> 45,000	81	73	79,616	16,328	15	113	0%	1983	3.4	15.3	1.7	110.9
	4	<25,000	17	12	13,853	7,504	15	473	100%	1977	3.3	14.4	1.6	86.3
	Steam Turbine	<25,000	1	1	18,314	8,300	15	ND	ND	1975	3.3	12.3	1.5	64.3
BULK CARRIER Total			**411**	**377**	**40,274**	**11,018**	**15**	**131**	**36%**	**1982**	**3.4**	**14.9**	**1.7**	**95.8**
CONTAINER SHIP	2	<25,000	242	46	18,425	17,757	19	106	0%	1987	2.6	11.4	1.2	37.4
		25,000 - 35,000	27	0	27,503	16,327	18	ND	ND	1977	2.8	12.9	1.0	35.7
	4	<25,000	129	27	12,143	10,898	18	429	100%	1989	2.8	12.5	1.2	25.8
CONTAINER SHIP Total			**398**	**73**	**18,208**	**15,383**	**19**	**229**	**38%**	**1987**	**2.7**	**11.9**	**1.1**	**33.5**
GENERAL CARGO	2	<15,000	132	58	6,833	5,784	14	437	89%	1985	3.7	13.3	1.4	63.0
		15,000 - 30,000	90	101	18,918	10,456	16	140	63%	1980	3.2	14.6	2.0	119.3
		30,000 - 45,000	8	2	38,907	12,876	14	96	0%	1981	3.5	12.3	1.2	62.3
		> 45,000	1	0	46,956	12,170	ND	117	0%	1992	ND	12.4	1.0	33.0
	4	<15,000	166	117	5,316	3,944	14	743	100%	1988	3.7	12.9	1.6	98.1
		15,000 - 30,000	16	13	18,775	7,536	15	ND	ND	1981	3.4	15.1	1.7	122.6
	Steam Turbine	<15,000	1	0	ND	ND	ND	ND	ND	1918	ND	14.2	1.0	18.1
GENERAL CARGO Total			**414**	**291**	**10,538**	**6,284**	**14**	**561**	**90%**	**1985**	**3.6**	**13.4**	**1.6**	**91.3**
MISCELLANEOUS	2	< 1,000	8	2	0	2,400	ND	ND	ND	1943	ND	10.9	1.2	45.4
	4	< 1,000	4	2	448	1,293	14	ND	ND	1978	3.6	12.4	1.4	41.1
MISCELLANEOUS Total			**12**	**4**	**149**	**2,031**	**14**	**ND**	**ND**	**1955**	**3.6**	**11.4**	**1.3**	**44.0**
PASSENGER	4	<5,000	6	0	1,332	16,108	18	532	100%	1983	2.9	11.4	1.0	24.3
		5,000 - 10,000	6	0	7,257	20,776	18	616	100%	1966	2.7	11.4	1.0	23.4
	Steam Turbine	5,000 - 10,000	9	0	9,076	40,649	26	ND	ND	1964	2.0	12.6	1.0	15.9
		10,000 - 15,000	1	3	13,016	169,708	30	ND	ND	1952	1.7	5.5	3.5	ND
PASSENGER Total			**22**	**3**	**7,828**	**34,403**	**22**	**582**	**100%**	**1969**	**2.4**	**11.6**	**1.1**	**20.5**
REEFER	2	<5,000	28	19	4,988	9,553	18	146	65%	1984	2.7	10.7	1.6	51.4
		5,000 - 10,000	87	34	7,667	9,706	18	141	59%	1988	2.7	10.7	1.3	56.8
		10,000 - 15,000	153	61	11,833	12,500	19	116	0%	1987	2.6	12.2	1.4	64.8
		> 15,000	3	1	15,696	18,467	20	ND	ND	1979	2.6	11.4	1.3	33.6
	4	<5,000	16	27	4,880	7,048	16	202	100%	1992	3.1	13.6	2.5	87.8
		5,000 - 10,000	15	15	6,555	6,837	17	402	100%	1989	3.0	13.0	1.9	81.7
		10,000 - 15,000	3	0	11,087	15,672	22	428	100%	1992	2.3	11.2	1.0	54.0
REEFER Total			**305**	**157**	**10,137**	**10,958**	**19**	**155**	**41%**	**1987**	**2.7**	**11.7**	**1.5**	**63.0**
RORO	2	<15,000	26	7	7,074	8,280	17	242	100%	1981	2.9	13.2	1.2	67.1
		15,000 - 30,000	5	0	22,845	12,852	18	102	0%	1988	2.8	8.8	1.0	43.0
	4	<15,000	26	5	7,601	8,553	14	720	100%	1981	3.7	13.3	1.2	57.7
RORO Total			**57**	**12**	**9,142**	**8,805**	**16**	**456**	**69%**	**1982**	**3.3**	**12.9**	**1.2**	**60.7**

Table 8-5: Summary of 1996 Deep-Sea Vessel Data for the Delaware River Ports Including Philadelphia, PA

Ship Type	Engine Type	DWT Range	Calls	Shifts	DWT (tonnes)	Power (HP)	Vessel Speed (knots)	Engine Speed (RPM)	%RPM >130	Date of Build	Cruise (hr/call)	RSZ (hr/call)	Maneuver (hr/call)	Hotel (hr/call)
TANKER	2	<30,000	237	321	13,261	10,008	14	132	30%	1984	3.6	14.4	2.1	72.3
		30,000 - 60,000	78	130	43,461	12,616	15	125	41%	1982	3.4	14.2	2.4	62.8
		60,000 - 90,000	111	163	77,375	16,026	15	95	0%	1983	3.3	14.9	2.2	70.8
		90,000 - 120,000	91	157	98,373	15,451	15	97	0%	1991	3.4	13.8	2.4	83.0
		120,000 - 150,000	150	404	137,083	23,046	15	93	0%	1982	3.4	16.5	3.2	137.4
		> 150,000	32	86	155,676	25,559	15	85	0%	1983	3.3	16.3	3.2	122.6
	4	<30,000	57	71	15,655	7,077	14	413	89%	1981	3.7	14.0	2.0	61.6
		30,000 - 60,000	5	11	44,153	15,360	15	ND	ND	1980	3.3	15.7	2.8	63.9
		60,000 - 90,000	17	35	80,320	14,305	15	416	75%	1981	3.4	14.7	2.6	77.3
	Steam Turbine	<30,000	24	35	26,755	14,646	16	ND	ND	1959	3.1	14.0	2.3	88.4
		30,000 - 60,000	54	65	35,574	15,498	16	ND	ND	1962	3.1	13.8	2.0	65.8
		90,000 - 120,000	2	3	92,760	23,923	16	ND	ND	1976	3.1	14.6	2.3	70.2
		> 150,000	10	25	276,808	36,324	16	ND	ND	1973	3.2	15.4	3.0	104.1
TANKER Total			**868**	**1,506**	**74,084**	**15,137**	**15**	**133**	**19%**	**1982**	**3.4**	**14.8**	**2.4**	**85.1**
VEHICLE CARRIER	2	<12,500	39	9	12,115	11,877	18	117	0%	1982	2.8	7.6	1.2	17.7
		12,500 - 15,000	5	2	13,813	12,859	18	111	0%	1986	2.7	10.1	1.3	27.2
		15,000 - 17,500	7	0	16,209	13,911	18	111	0%	1984	2.7	9.0	1.0	23.9
		> 17,500	13	0	18,558	15,224	19	101	0%	1987	2.7	6.9	1.0	25.2
	4	<12,500	8	4	10,382	13,150	18	527	100%	1977	2.8	13.2	1.4	39.9
		12,500 - 15,000	1	0	14,501	14,770	ND	ND	ND	1983	ND	9.5	1.0	18.0
VEHICLE CARRIER Total			**73**	**15**	**13,678**	**12,914**	**18**	**143**	**8%**	**1983**	**2.7**	**8.4**	**1.2**	**22.7**
Grand Total			**2,560**	**2,438**	**38,991**	**12,476**	**16**	**236**	**0**	**1984**	**3.2**	**13.5**	**1.8**	**74.1**

SECTION 9

PORTS OF THE PUGET SOUND INCLUDING SEATTLE, WA

9.1 DATA

Data were received from the MEPA of the Puget Sound (Reference 9-1) for all commercial vessels that called in the waterways covered by the MEPA for calendar year 1996. Assistance on time-in-mode and normal vessel operations was received from the Puget Sound Pilots (Reference 9-2). Ports and anchorages covered in the dataset range from Grays Harbor to the southwest to Bellingham and Anacortes in the northeast and to Seattle Harbor in the east. The entrance for ports in the Puget Sound is at the Strait of Juan de Fuca entrance at Cape Flattery.

USACE port/waterways included in the MEPA data are listed in Table 9-1.These ports and waterways are those that reported vessel traffic in 1995. The following port/waterways may also be within the region reported by the MEPA: San Juan De Fuca Spine, WA; Waterway Connecting Port Townsend Bay and Oak Bay, WA; Puget Sound Spine, WA; Lake Washington Ship Canal; Hammersley Inlet, WA; Channel to Bremerton, WA; Everett Harbor, WA; Gumes Channel, WA; Chehalis River above Montesano, Grays Harbor, WA; Snomomish River, WA; Other Coastal Ports, Seattle, WA District; Cape Flattery, WA; and Other Puget Sound Area Ports.. These ports were not included in Table 9-1 because they had no reported commercial marine traffic in 1995. More detailed port information on Puget Sound Area Ports can be found in Appendix B.4.

Table 9-1. Typical Ports within the MEPA of the Puget Sound dataset

DSP Rank	Typical Port	USACE Port Code
21	Seattle Harbor, WA	4722
26	Tacoma Harbor, WA	4720
34	Anacortes Harbor, WA	4730
55	Everett Harbor, WA	4725
70	Port Angeles Harbor, WA	4708
72	Grays Harbor, WA	4702
78	Bellingham Bay and Harbor, WA	4732
83	Olympia Harbor, WA	4718
NA	Neah Bay, WA	4706
NA	Port Townsend	4710
NA	Port Gamble	4714

The dataset received from the MEPA contains the information on the vessel name, ship-type, time the pilot arrived on the vessel and time the pilot left the vessel, time the vessel anchored or moored and time the vessel departed from the berth or anchorage, whether the vessel shifted, and other information as shown in Appendix A table A-7. Data received from the MEPA of the Puget Sound had LRNs for most of the ships. Out of 4,552 records, 4,489 had valid LRNs. The remaining ships were matched with LRNs by comparing ship name, ship-type, and DWT provided by the MEPA with LMIS data. If no LRN was available with ship name identical to the one in the MEPA database, a similar ship name with the same ship-type and similar DWT was selected. There is some room for error in this process, but the use of ship-type and DWT categories in the summary tables provides enough leeway to reduce the impact of small errors in the matching process. Of the 4,552 records, 1,219 described shifting within the MEPA area.

Table 9-5 (located at the end of this section) is a summary table of all the vessels recorded by the MEPA in 1996 presented by ship-type, engine type, and DWT range. Ship-types were those given in the Lloyds data except that similar categories were grouped together for simplicity. The following table gives the number of calls per ship-type for calendar year 1996. A call is one entrance and one exit from the entire area reported by the MEPA of the Puget Sound. Some vessel types are rarely reported by the MEPA. These vessels include ferries, tugs, barges, supply vessels, yachts, fishing vessels, and excursion vessels. While a few of these vessel types have recorded calls in 1996, they are not completely recorded, and have been grouped together as "miscellaneous".

Table 9-2. Calls and shifts by ship-type as recorded by the MEPA of the Puget Sound

Ship-Type	Calls	Shifts	% dry-cargo calls [a]
BULK CARRIER	892	414	33.2%
CONTAINER SHIP	1,150	59	42.8%
FISHING	81	86	NA
GENERAL CARGO	263	52	9.8%
MISCELLANEOUS	11	5	NA
PASSENGER	13	2	0.5%
REEFER	60	45	2.2%
RORO	168	17	6.2%
TANKER	553	507	NA
VEHICLES CARRIER	142	32	5.3%
Total	**3,333**	**1,219**	**100.0%**

[a] % of dry-cargo calls excludes calls from barge carrier, miscellaneous, and tanker ship-types

Table 9-3 presents a summary of trips for the USACE waterway codes that are included in the MEPA of the Puget Sound database by ship-type. There is some discrepancy in ship-types between the USACE and the MEPA matches with LMIS. Fishing vessels are not a separate category recognized by the USACE. The "miscellaneous" vessels in the MEPA database may correspond with some of the "other" vessels in the USACE database, but more data is needed before emissions can be estimated for the vessels in these categories. The totals in Table 9-3 should be used with the methodology in Section 4 to determine calls by ship-type for each Typical Port within the MEPA of the Puget Sound MEPA Area.

Table 9-3. USACE Trips by ship-type for each Typical Port within the MEPA of the Puget Sound

Typical Port		Ship-Type [a, b]									Total Trips
Rank	**Name**	**BC**	**CS**	**GC**	**PA**	**RF**	**RO**	**TA**	**VC**	**UC**	
21	Seattle Harbor	278	1,484	255	60	49	213	209	44	535	3,127
26	Tacoma Harbor	432	610	15	0	4	379	282	111	270	2,103
34	Anacortes Harbor	24	0	0	4	0	2	394	683	91	1,198
55	Everett Harbor	113	0	0	0	10	5	0	0	21	149
70	Port Angeles	52	0	2	0	7	16	66	0	31	174
72	Gray's Harbor	159	0	20	6	2	0	0	0	48	235
78	Bellingham Harbor	24	13	46	8	14	6	49	6	394	567
83	Olympia Harbor	7	0	0	2	0	0	0	1	3	13
Total		**1,089**	**2,107**	**338**	**80**	**86**	**628**	**1,000**	**845**	**1,393**	**7,566**

[a] BC = Bulk Carrier, CS = Container Ship, GC = General Cargo, PA = Passenger, RF = Reefer, RO = RORO, TA = Tanker, VC = Vehicle Carrier, UC = Unspecified Dry-cargo,

[b] Trip totals do not include intraport movements (vessel movements within the same USACE port/waterway)

For purposes of allocating the USACE data to the MEPA data, we suggest allocating the UC trips in Table 9-3 over the dry-cargo ship-types using the percent of dry-cargo calls presented in Table 9-2. For example, Port # 21, Seattle Harbor, WA, has 535 UC trips. BC trips are 33.2% of the dry-cargo calls for the entire MEPA Area, and 33.2% of 535 is 178. Thus the total revised BC trips for Seattle Harbor would be 178 plus 278 for a total of 456 trips. This same process should be followed for all the ship-types and all the port/waterways. This method of allocating the undefined ship-type trips is the default method. Any data available from the port or other reliable source that indicates a more refined allocation of UC ship-types trips should be used in place of the above method.

9.2 TIME-IN-MODE CALCULATIONS

Descriptions of time-in-mode are given in Section 3, Table 3-1 of this report. The following descriptions are specific to calculations for Puget Sound Area ports.

9.2.1 Cruise

Cruise speed is the average continuous speed of the vessel in open water. Cruise is treated as beginning twenty-five miles out from Cape Flattery, the entrance point of the Strait of San Juan de Fuca. Cruise times for each call were computed using Equation 9.1.

Cruise = 25 / [Vessel Speed (knots)] *2 **(9.1)**

9.2.2 Reduced Speed Zone

Reduced speed zone (RSZ) time is the time the vessel is at a speed less than full cruise and greater than the 4 knot average used for maneuvering. Vessels enter the Strait of Juan de Fuca at service speed and may continue at service speed or a reduced speed depending on weather and traffic in the Strait. Puget Sound pilots were not able to provide specific information on speeds in this waterway. Pilots are picked up off of Port Angeles unless it is noted in the spreadsheet data that no pilot was used or the vessel is going to Grays Harbor/Aberdeen or Westport. Cape Flattery, the primary entrance point and breakwater for Puget Sound, is 56 miles from Port Angeles. A speed of 15 knots was estimated as an average speed in this area and 112 miles at 15 knots or 8.1 hours per call was added to each vessel's RSZ time. The average RSZ times for each Typical Port are shown in Table 9-4.

Table 9-4. Average time, distance, and speed from the pilot's station until maneuvering begins for the Ports of the Puget Sound

Port	Distance from Port Angeles (nautical miles) [a]	Average Time (hr)	Average speed (knots)
Seattle Harbor	66	5	13
Tacoma Harbor	84	6.5	13
Bellingham	55	5.1	11
Grays Harbor (Aberdeen)	18 [b]	2.2	8
Port Angeles	1 [c]	0.8	4 [d]
Olympia	111	8.7	13
Everett	57	5	11
Anacortes	43	4.1	10
Other Puget Sound Area Ports	50	4.4	11

[a] minus two miles for maneuvering, [b] miles from Westport, [c] Docks of Port Angeles are approximately 3 miles from the pilot pick-up, and [d] almost all maneuvering

Based on conversations with the Puget Sound pilots, we assumed that a typical vessel reduces speed to approximately 3-5 knots for approximately 4 miles to pick up the pilot off of Port Angeles. Vessels travel from the pilots station at Port Angeles to the specific ports at speeds from 4 knots in bad weather to service speed in clear weather with an average speed of 13 knots for the mainly dry-cargo ports and 11 knots for the mainly tanker ports. There are periods of acceleration and deceleration within the waterway area. For Grays Harbor, a pilot is picked up off of the Westport anchorage approximately 18 miles from Aberdeen. RSZ begins when the pilot is picked up and continues until approximately 4 miles from the port. As for the other Puget Sound Area Ports, the last 4 miles and times for shifting are treated as being at 3-5 knots.

Thus, RSZ time for the Puget Sound Area Ports was calculated by Equation 9.2.

RSZ (hr/call) = 8.1 + (PORTADA - PLTADA)*24 + (PORTATA - PLTATA) +
(PLTADD - PORTADD)*24 + (PLTATD - PORTATD) (9.2)

Where	PORTADA	= the actual day of arrival at the first port/berth
	PLTADA	= the actual day of arrival of the pilot
	PORTATA	= the actual time of arrival at the first port/berth
	PLTATA	= the actual time of arrival of the pilot on the vessel
	PLTADD	= the actual day of departure of the pilot from the vessel
	PORTADD	= the actual day of departure from the last port/berth
	PLTATD	= the actual time of departure of the pilot from the vessel
	PORTATD	= the actual time of departure from the last port/berth

9.2.3 Maneuvering

On the average, maneuvering starts two nautical miles from the dock and continues until the vessel is secured at the dock. This is repeated as the vessel is leaving the dock for an average time-in-mode per call of 1 hour. The exception to this is when the vessel shifts between nearby docks or anchorages. Most vessel shifts are to nearby berths and not between berths of different USACE port/waterway area. Out of the 1,219 shifting events recorded in 1996 for Ports of the Puget Sound, 48% were shifts between port/waterway areas, 30% were tankers shifting between refineries in the north between the waterways of Anacortes and Bellingham. The remaining 12% of the shifts between port/waterway areas occurred most frequently with vessels that anchored at Port Angeles in order to wait for a berth at another port or with vessels that moved between Seattle and Tacoma. As most shifting takes place between berths that are less than 4 miles apart and/or in heavily trafficked areas, for calculations in this report all of the maneuvering time between berths is assumed to be at 4 knots.

Maneuver (hr/call) = 1+ ∑shift(hr) (9.3)

shift(hr) = [(PORTATA at berth n} - (PORTATD from berth n-1)] (9.4)

9.2.4 Hotelling

Hotelling occurs when the vessel is at anchorage or at a berth and is the total time in port minus the time-in-mode for RSZ and maneuvering.

Hotelling (hr/call) = (PLTADD - PLTADA) * 24 +
(PLTATD - PLTATA) - Maneuver – RSZ **(9.5)**

Where:

PLTADD = The actual day of departure at Port Angeles (or Westport for Grays Harbor)

PLTADA = The actual day of arrival at Port Angeles (or Westport for Grays Harbor)

PLTATD = The actual time of departure at Port Angeles (or Westport for Grays Harbor)

PLTATA = The actual time of arrival at Port Angeles (or Westport for Grays Harbor)

and "maneuver" and "RSZ" are as defined above.

9.2.5 Summary Table

The summary table, Table 9-5 reflects all of the ship-types, vessel characteristics, and time-in-mode data available for the Puget Sound Area Ports and Grays Harbor. There are some ship-type categories for which one or more of the data fields had no available data. This is most commonly seen in "Engine Speed" as this was one of the least complete LMIS data fields and as steam turbines do not have engine speed data. There is a large standard deviation for many of the hotelling totals as a few vessels that stayed in port for repairs, retrofit or some other reason had hotelling times in the hundreds or thousands of hours. If one of these long hotelling times occurs for a ship-type category that only have a few calls, the average hotelling time will appear much higher than may actually be typical. In these cases, we recommend using the average hotelling time for the entire ship-type.

9.3 DATA QUALIFIERS

Many fields did not have data for all records but the most important fields showing dates, times, ship-type, and ship name were mostly complete. After calculating RSZ, maneuvering, and hotelling times for each call and shift, a visual inspection of the results was performed. Data that had negative times or excessively large times for any of the time-in-modes were examined for obvious inconsistencies. If an obvious inconsistency was found such as an arrival or departure date with a year other than 1996 (or in some very few cases, January of 1997) the year was changed to the appropriate year. Another somewhat common error would be a departure time late in the day and an arrival time at the next berth early in the same day. In this case, the day of arrival was increased by one day to account for the change past midnight. In some cases the error was due to an empty field.

If a date field was empty and an accurate guess could be made to the date, a date was entered. If a time was missing, the estimated time of arrival or departure was used rather than the actual date or time. If these estimated times were not available, the record was excluded from the time-in-mode calculations, but its ship-type characteristics were still included in those averages in Table 9-5. Therefore, for some time-in-mode or ship-type characteristic fields in Table 9-5 there is an entry of "ND" meaning that no data were available. If a significant number of time-in-modes were encountering similar errors, the pilot's association of the MEPA was contacted to get information on why these calculations might be incorrect.

Tug assistance will affect the time-in-mode for a vessel. A vessel coming to anchor will not require tug assistance. A dry-cargo vessel docking at a berth will virtually always require tug assistance and will meet the tug at the entrance to the harbor area (Seattle Harbor, Tacoma Harbor, etc). A tanker will require tug escort through the Sound and will be limited to a speed no greater than the service speed of the escorting tug. All vessels are under their own power even when docking with tug assistance. The main propulsion engines may be in neutral during the final stages of docking, but they are not shut down until the vessel is secured at the dock or anchorage.

All vessels were treated as entering Puget Sound from the Strait of Juan de Fuca. There is a more northern entrance to the Sound, the Strait of Georgia, and it is possible that some vessels will enter or leave by that route. Conversations with the MEPA and Puget Sound pilots confirmed that most vessels enter and leave by the Strait of Juan de Fuca, passing the pilot's station at Port Angeles. Lacking enough data to distinguish between entrance routes, all vessels, except those going to Gray's Harbor, were treated as entering by the Strait of Juan de Fuca.

Table 9-5: Summary of 1996 Deep-Sea Vessel Data for Puget Sound Area Ports Including Seattle, WA

Ship Type - Manip	Stroke type	DWT Range	Calls	Shifts	DWT (tonnnes)	Power (HP)	Vessel Speed (knots)	Engine Speed (RPM)	% RPM >130	Date of Build	Cruise (hr/call)	RSZ (hr/call)	Maneuver (hr/call)	Hotel (hr/call)
BULK CARRIER	2	<25,000	165	42	22,130	7,073	14	150	94%	1990	3.6	15.4	1.4	70.6
		25,000 - 35,000	306	114	27,887	8,155	14	124	32%	1988	3.5	16.5	1.5	128.1
		35,000 - 45,000	167	69	40,489	10,752	15	107	3%	1985	3.4	16.3	1.6	88.1
		> 45,000	216	165	66,419	12,646	15	98	0%	1987	3.5	15.8	2.0	154.1
	4	<25,000	8	9	6,436	3,625	13	ND	ND	1977	4.0	17.7	5.1	84.4
		25,000 - 35,000	2	1	32,019	10,400	15	518	100%	1983	3.5	14.6	1.4	96.8
		35,000 - 45,000	2	ND	41,642	10,943	14	117	0%	1989	3.6	13.4	0.9	64.3
		> 45,000	13	8	63,029	14,806	15	400	100%	1983	3.4	16.6	2.1	177.9
	Steam Turbine	> 45,000	13	6	82,035	17,111	16	ND	ND	1968	3.1	21.5	1.4	58.8
BULK CARRIER Total			**892**	**414**	**39,661**	**9,727**	**14**	**123**	**34%**	**1987**	**3.5**	**16.2**	**1.7**	**115.4**
CONTAINER SHIP	2	<25,000	184	18	19,019	18,365	19	135	77%	1985	2.7	17.9	1.0	34.3
		25,000 - 35,000	135	2	31,480	26,364	20	101	0%	1984	2.5	16.6	0.9	25.9
		35,000 - 45,000	363	22	40,261	31,808	22	93	0%	1987	2.3	16.4	1.0	30.9
		> 45,000	276	9	56,958	51,033	23	95	0%	1992	2.2	16.0	0.9	28.4
	4	<25,000	8	3	19,987	12,405	19	428	100%	1988	2.7	16.0	1.1	59.5
	Steam Turbine	<25,000	3	2	19,800	26,797	21	ND	ND	1980	2.4	18.2	1.5	138.7
		25,000 - 35,000	93	2	28,628	30,080	20	ND	ND	1973	2.5	16.5	0.9	40.4
		35,000 - 45,000	64	ND	38,988	31,565	21	ND	ND	1973	2.4	15.5	0.9	17.8
		> 45,000	24	1	47,851	80,006	23	ND	ND	1972	2.2	16.2	0.9	30.3
CONTAINER SHIP Total			**1,150**	**59**	**38,791**	**34,337**	**21**	**98**	**5%**	**1985**	**2.4**	**16.5**	**0.9**	**30.8**
FISHING	2	<1500	12	18	789	1,897	12	ND	ND	1973	4.3	21.1	5.9	1291.8
		1,500 - 3,000	3	ND	1,883	3,626	14	150	100%	1987	3.5	15.9	1.8	33.4
		3,000 - 4,500	1	ND	4,500	10,768	18	660	100%	1996	2.8	16.7	0.9	1432.0
		> 4,500	2	1	9,360	10,331	18	ND	ND	1984	2.8	16.0	3.7	654.3
	4	<1500	20	19	698	1,702	12	773	100%	1983	4.3	20.1	4.3	915.6
		1,500 - 3,000	10	9	1,861	5,159	16	720	100%	1978	3.1	13.2	1.8	321.5
		3,000 - 4,500	2	7	3,372	14,398	15	500	100%	1991	3.3	16.3	7.9	1405.4
		> 4,500	27	27	5,805	8,048	14	720	100%	1993	3.6	14.8	4.3	399.2
	Steam Turbine	> 4,500	4	5	19,286	37,976	20	ND	ND	1964	2.5	13.0	4.1	534.6
FISHING Total			**81**	**86**	**3,846**	**6,774**	**14**	**686**	**100%**	**1984**	**3.7**	**16.9**	**4.2**	**686.4**
GENERAL CARGO	2	<15,000	7	2	3,540	3,647	12	200	100%	1987	4.3	17.9	2.8	65.2
		15,000 - 30,000	73	16	21,745	11,495	16	130	29%	1981	3.1	18.4	1.5	52.4
		30,000 - 45,000	52	1	41,323	12,006	15	104	5%	1984	3.3	13.3	1.0	32.0
		> 45,000	77	5	45,539	10,164	15	98	0%	1988	3.3	16.2	1.1	23.2
	4	<15,000	21	7	9,063	9,493	15	278	100%	1982	3.5	17.9	2.1	353.6
		15,000 - 30,000	32	21	20,039	20,164	18	ND	ND	1985	2.9	17.6	2.1	112.5
	Steam Turbine	<15,000	1	ND	14,897	15,289	19	ND	ND	1966	2.6	18.3	0.9	163.9
GENERAL CARGO Total			**263**	**52**	**30,851**	**11,907**	**16**	**122**	**17%**	**1984**	**3.2**	**16.6**	**1.4**	**71.9**
MISCELANEOUS	2	(blank)	3	3	7,900	9,387	14	ND	ND	1991	3.6	19.3	2.4	2189.6
		(blank)	1	ND	1,200	1,860	12	ND	ND	1990	4.2	22.4	0.9	472.8
	4	(blank)	4	2	761	3,486	13	1225	100%	1986	3.8	16.1	3.2	300.1
	Steam Turbine	(blank)	3	ND	3,988	8,483	15	ND	ND	1940	3.3	15.4	0.9	49.0
MISCELANEOUS Total			**11**	**5**	**3,548**	**5,827**	**14**	**1225**	**100%**	**1983**	**3.7**	**17.3**	**2.1**	**762.6**
PASSENGER	2	<5,000	3	1	4,226	29,370	21	ND	ND	1983	2.4	14.5	1.4	67.1
		5,000 - 10,000	1	ND	5,340	32,350	19	ND	ND	1986	2.6	17.5	0.9	7.7
	4	<5,000	4	ND	850	9,906	16	788	100%	1983	3.2	17.1	0.9	9.5

Table 9-5: Summary of 1996 Deep-Sea Vessel Data for Puget Sound Area Ports Including Seattle, WA

Ship Type - Manip	Stroke type	DWT Range	Calls	Shifts	DWT (tonnnes)	Power (HP)	Vessel Speed (knots)	Engine Speed (RPM)	% RPM >130	Date of Build	Cruise (hr/call)	RSZ (hr/call)	Maneuver (hr/call)	Hotel (hr/call)
		5,000 - 10,000	3	1	7,089	45,589	21	514	100%	1993	2.4	16.2	0.9	54.6
	Steam Turbine	5,000 - 10,000	2	ND	8,706	25,154	23	ND	ND	1958	2.2	17.6	0.9	67.5
PASSENGER Total			**13**	**2**	**4,623**	**26,704**	**19**	**670**	**100%**	**1982**	**2.6**	**16.4**	**1.0**	**42.0**
REEFER	2	<5,000	17	17	3,307	4,767	15	155	100%	1986	3.3	15.6	3.9	315.7
		5,000 - 10,000	21	17	6,642	6,945	17	163	100%	1988	3.0	14.1	3.4	163.2
		10,000 - 15,000	7	7	11,746	11,969	20	115	0%	1988	2.6	15.6	2.4	201.5
	4	<5,000	7	3	2,004	1,730	11	230	100%	1970	4.7	22.1	1.5	259.8
		5,000 - 10,000	8	1	5,804	5,676	16	634	100%	1991	3.1	16.7	1.0	51.5
REEFER Total			**60**	**45**	**5,640**	**6,136**	**16**	**272**	**88%**	**1986**	**3.3**	**16.0**	**2.9**	**207.3**
RORO	2	<10,000	11	2	7,976	6,738	16	174	75%	1988	3.3	22.1	1.3	30.1
		10,000 - 20,000	16	ND	11,346	8,004	16	162	81%	1992	3.3	19.9	0.9	24.4
		20,000 - 30,000	16	1	26,787	18,649	19	ND	ND	1983	2.6	17.9	0.9	25.0
		> 30,000	4	ND	41,856	15,136	14	ND	ND	1981	3.5	14.2	0.9	10.3
	Steam Turbine	10,000 - 20,000	121	14	17,084	29,764	25	ND	ND	1976	2.0	17.0	1.4	73.8
RORO Total			**168**	**17**	**17,455**	**24,777**	**23**	**166**	**79%**	**1979**	**2.3**	**17.6**	**1.3**	**60.1**
TANKER	2	<30,000	66	49	19,629	9,104	15	176	79%	1986	3.5	19.0	4.3	43.7
		30,000 - 60,000	79	68	46,934	12,451	15	107	0%	1984	3.4	15.9	4.0	67.6
		60,000 - 90,000	18	13	71,315	15,262	15	89	0%	1984	3.3	16.0	3.3	45.2
		90,000 - 120,000	20	20	100,679	14,738	14	94	0%	1991	3.5	15.8	2.6	64.0
		120,000 - 150,000	26	46	123,742	26,146	16	ND	ND	1974	3.1	14.5	7.2	63.9
	4	<30,000	12	ND	10,056	4,864	13	245	33%	1976	4.0	15.6	0.9	16.2
		30,000 - 60,000	1	1	37,350	11,700	14	520	100%	1981	3.6	17.0	4.2	84.7
	Steam Turbine	<30,000	18	15	19,992	14,795	18	ND	ND	1964	2.8	14.4	3.8	59.7
		30,000 - 60,000	35	24	39,541	13,809	16	ND	ND	1969	3.1	15.4	3.5	45.3
		60,000 - 90,000	125	95	71,997	19,286	17	ND	ND	1970	3.0	16.6	3.4	62.4
		90,000 - 120,000	29	30	91,915	23,095	16	ND	ND	1977	3.2	15.9	5.3	52.1
		120,000 - 150,000	119	145	122,732	26,360	16	ND	ND	1974	3.1	14.7	6.2	62.8
		> 150,000	5	1	189,978	27,620	14	ND	ND	1978	3.5	11.1	1.9	103.4
TANKER Total			**553**	**507**	**73,490**	**18,099**	**16**	**129**	**22%**	**1977**	**3.2**	**16.0**	**4.4**	**58.3**
VEHICLES CARRIER	2	<12,500	27	ND	10,286	10,289	17	158	82%	1983	3.0	20.0	0.9	32.2
		12,500 - 15,000	33	5	13,709	14,049	18	109	9%	1985	2.7	18.6	1.2	19.0
		15,000 - 17,500	49	23	16,272	14,023	18	120	0%	1984	2.8	17.3	1.5	19.6
		> 17,500	7	2	19,783	15,501	18	98	0%	1985	2.7	18.4	1.7	19.9
	4	<12,500	19	1	10,981	13,118	18	ND	ND	1981	2.7	20.2	0.9	20.2
		12,500 - 15,000	4	ND	12,917	13,600	19	ND	ND	1980	2.6	20.2	0.9	13.5
		15,000 - 17,500	2	ND	17,224	16,880	19	450	100%	1978	2.6	18.9	0.9	22.0
		> 17,500	1	1	19,712	16,880	18	ND	ND	1981	2.8	19.4	3.1	21.1
VEHICLES CARRIER Total			**142**	**32**	**13,946**	**13,319**	**18**	**137**	**22%**	**1984**	**2.8**	**18.7**	**1.2**	**21.8**
Grand Total			**3,333**	**1,219**	**40,347**	**20,617**	**18**	**139**	**25%**	**1984**	**2.9**	**16.5**	**1.9**	**83.9**

SECTION 10

PORT OF CORPUS CHRISTI, TX

10.1 DATA

Data were received from the Corpus Christi MEPA (Reference 10-1) for all commercial vessels that called in the waterways covered by the MEPA for calendar year 1996. Assistance on time-in-mode and normal vessel operations was received from pilots at the Corpus Christi Pilots Association (Reference 10-2). Ports and anchorages covered in the dataset include the Port of Corpus Christi and the Corpus Christi Ship Canal. Table 10-1 shows the port/waterway areas as defined by the USACE that are included in this area. More detailed port information is available in Appendix B.5.

Table 10-1. Typical Ports within the MEPA of Corpus Christi dataset

DSP Rank	Typical Port	USACE Port Code
8	Corpus Christi, TX	2414
8	Corpus Christi Ship Canal	2423

The dataset received from the MEPA contains the information on the vessel name, arrival date and time, departure date and time, cargo type, and other information as shown in Appendix A table A-8. No data were included on the arrival or departure berth or on any berths, dates, times or other indicator associated with shifting.

Data received from the Corpus Christi MEPA had LRNs for most of the ships. Out of 1,561records, 1,540 had valid LRNs. The remaining ships were matched with LRNs by comparing ship name, ship-type, and DWT provided by the MEPA with LMIS data. The remaining 21 records matched easily with a same or similar ship name, type and DWT. Each record represents a total call on the Port of Corpus Christi. A call is one entrance and one exit from the entire area reported by the Corpus Christi MEPA.

Table 10-5, located at the end of this section, is a summary table of all the vessels recorded by the MEPA in 1996 presented by ship-type, engine type, and DWT range. Ship-types were those given in the LMIS data except that similar categories were grouped together for simplicity. Table 10-2 gives the number of calls recorded by the MEPA for each ship-type for calendar year 1996. There are a few supply vessels included in the MEPA data set. These are included in the "miscellaneous" category in Table 10-2.

Table 10-2. Calls by ship-type as recorded by the MEPA for Corpus Christi, TX

Ship-Type	Total Calls [a]	% dry-cargo calls [b]
BARGE CARRIER	2	NA
BULK CARRIER	209	94.1%
CONTAINER SHIP	1	0.5%
TANKER	1,332	NA
GENERAL CARGO	12	5.4%
MISCELLANEOUS	5	NA
Grand Total	**1,561**	**100.0%**

[a] Information on shifting was not available for Corpus Christi
[b] Percent dry-cargo calls do not include trips for barge carrier, tanker, or miscellaneous ship-types

Table 10-3 presents a summary of trips for the USACE waterway codes that are included in the Corpus Christi MEPA database by ship-type. There is some discrepancy in ship-types between the USACE and the MEPA matches with LMIS. The "miscellaneous" vessels in the MEPA database may correspond with some of the "other" vessels in the USACE database, but more data is needed before emissions can be estimated for the vessels in these categories. The totals in Table 10-3 can be used with the methodology in Section 4 to determine calls by ship-type for each Typical Port within the Corpus Christi MEPA Area.

Table 10-3. USACE Trips by ship-type for each Typical Port within the Corpus Christi MEPA dataset

Typical Port		USACE Trips by Ship-Type [a]									Total Trips
Rank	Name	BC	CS	GC	PA	RF	RO	TA	VC	UC	
8	Corpus Christi	407	7	27	125	0	10	1,921	0	98	2,595

[a] BC = Bulk Carrier, CS = Container Ship, GC = General Cargo, PA = Passenger, RF = Reefer, RO = RORO, TA = Tanker, VC = Vehicle Carrier, UC = Unspecified Dry-cargo,
[b] Trip totals do not include intraport movements (vessel movements within the same USACE port/waterway)

For purposes of determining MEPA calls for each Typical Port, we suggest allocating the UC trips in Table 10-3 over the dry-cargo ship-types using the percent of dry-cargo calls presented in Table 10-2. For example, Port 8, Corpus Christi, has 98 UC trips. According to Table 10-2, BC trips are 94.1% of the dry-cargo calls for the entire MEPA Area, and 94.1% of 98 is 92. Thus the total revised BC trips for the Corpus Christi would be 499 trips. This same process should be followed for all the ship-types within the Typical Port. This method of allocating the undefined ship-type trips is the default method. Any data available from the port or other reliable source that indicates a more refined allocation of UC ship-types trips should be used in place of the above method.

10.2 TIME-IN-MODE CALCULATIONS

Descriptions of time-in-mode are given in Section 3, Table 3-1 of this report. The following descriptions are specific to calculations for Corpus Christi. It is important to note that there are periods of acceleration and deceleration within each time-in-mode.

10.2.1 Cruise

Cruise speed is the average continuous speed of the vessel in open water. The pilot is picked up 30 miles beyond the inner harbor and cruise is estimated for the 25 miles preceding this. Cruise speed for all calls in the MEPA Area were calculated using Equation 10.1.

Cruise = 25 / [Vessel Speed (knots)] * 2 **(10.1)**

10.2.2 Reduced Speed Zone

Reduced speed zone (RSZ) time is the time the vessel is at a speed less than full cruise and greater than the 4 knot average used for maneuvering. For Corpus Christi, RSZ is considered to take place from 30 miles beyond the inner harbor until the inner harbor is reached. This is approximately 30 miles and the average RSZ time is 3-4 hours at 8-12 knots. According to conversations with the pilots, container ships are more likely to travel at faster speeds and tankers at slower speeds with the bulk carriers between the two extremes. DWT of the vessel will also be likely to affect the speed of the vessel as deeper vessels leave larger wakes and are more disruptive than lighter vessels. For this reason, the total RSZ time was estimated based on vessel weight with vessels under 90,000 DWT given a total RSZ of 5 hours for an average speed of 12 knots and vessels over 90,000 given an RSZ of 6.6 hours for an average speed of 9 knots. While this calculation does not explicitly specify time-in-mode by ship-type, tankers are generally the heavier ship-types with a larger percentage of the total tanker ship-type calls than the total container ship-type calls at greater than 90,000 DWT.

Table 10-4. Average one-way RSZ speed and distance for Corpus Christi

Location	RSZ distance (miles)	Average Speed (knots)	Average Time (hr)
Pilot pick-up to inner harbor	30 miles	9-12 knots	2.5-3.5 hrs one-way

10.2.3 Maneuvering

Maneuvering for Corpus Christi starts at the inner harbor which is approximately 6 miles from shore. The average speed in the inner harbor is 3-5 knots. Maneuvering speeds were also based on DWT. For vessels with DWT less than 60,000 tonnes, a total maneuvering speed of 2.4 hours was used for an average speed of 5 knots. For vessels with a DWT of 60,000 - 90,000 tonnes, a total maneuvering time of 3 hours at 4 knots. For vessels with a DWT of more than 90,000 tonnes, a total maneuvering time of 4 hours for an average speed of 3 knots was used. As there were no details on shifting, no shifting time-in-mode was added to the maneuvering or RSZ. However, it is likely that there is some shifting occurring and that the time-in-mode calculations would be more accurate if shifting could be accounted for.

10.2.4 Hotelling

Hotelling occurs when the vessel is at anchorage or at a berth and can be calculated directly from the MEPA data as follows:

Hotelling (hr/call) = (Dep_Date - Arriv_Date) *24 + (Dep_Time - Arriv_Time) **(10.2)**

Where:

Arriv_Time =	Arrival time at the dock
Arriv_Date =	Arrival date at the dock
Dep_Date =	Departure date from the last dock
Dep_Time =	Departure time from the last dock

10.2.5 Summary Table

The summary table, Table 10-5 reflects all of the ship-types, vessel characteristics, and time-in-mode data available for the Port of Corpus Christi. There are some ship-type categories for which one or more of the data fields had no available data. This is most commonly seen in "Engine Speed" as this was one of the least complete LMIS data fields and as steam turbines do not have engine speed data. There is a large standard deviation for many of the hotelling totals as a few vessels that stayed in port for repairs, retrofit or some other reason had hotelling times in the hundreds or thousands of hours. If one of these long hotelling times occurs for a ship-type category that only have a few calls, the average hotelling time will appear much higher than may actually be typical. In these cases, we recommend using the average hotelling time for the entire ship-type.

10.3 DATA QUALIFIERS

Time-in-mode for RSZ and maneuvering are clearly estimates based on conversations with the Pilot’s Association. The actual time-in-modes associated with these activities may be quite different than the averages given in Table 10-5.

Although this database has no data on tug assist or whether the destination is a berth or anchorage, tug assistance will affect the time-in-mode for a vessel. A vessel coming to anchor will not require tug assistance. A dry-cargo vessel docking at a berth will virtually always require tug assistance and will meet the tug approximately two miles from the destination berth. All vessels are under their own power even when docking with tug assistance. The main propulsion engines may be in neutral during the final stages of docking, but they are not shut down until the vessel is secured at the dock or anchorage.

Table 10-5: Summary of 1996 Deep-Sea Vessel Data for the Port of Corpus Christi, TX

Ship Type Manip	Stroke type	DWT Range	Calls	DWT (tonnes)	Power (HP)	Vessel Speed (knots)	Engine Speed (RPM)	%RPM >130	Date of Build	Cruise (hr/call)	RSZ (hr/call)	Maneuver (hr/call)	Hotel (hr/call)
BARGE CARRIER	Steam Ship	25,000 - 35,000	2	30,298	31,564	22	ND	ND	1972	2.3	5.0	2.4	63.6
BARGE CARRIER Total			**2**	**30,298**	**31,564**	**22**	**ND**	**ND**	**1972**	**2.3**	**5.0**	**2.4**	**63.6**
BULK CARRIER	2	< 25,000	38	14,322	6,448	13	151	67%	1974	3.9	5.0	2.4	53.9
		25,000 - 35,000	35	28,117	11,029	15	150	100%	1977	3.3	5.0	2.4	57.8
		35,000 - 45,000	21	39,326	11,298	15	108	17%	1981	3.3	5.0	2.4	52.5
		45,000 - 90,000	60	68,076	14,830	15	93	0%	1982	3.4	5.0	2.9	49.0
		> 90,000	36	133,928	19,693	15	91	0%	1989	3.4	6.6	4.0	32.3
	4	< 25,000	5	18,600	8,100	15	ND	ND	1978	3.3	5.0	2.4	86.8
		25,000 - 35,000	6	29,485	11,036	14	460	100%	1979	3.6	5.0	2.4	73.3
		35,000 - 45,000	1	36,414	15,600	17	ND	ND	1981	2.9	5.0	2.4	17.0
		45,000 - 90,000	7	70,656	12,057	14	440	100%	1981	3.6	5.0	3.0	34.7
BULK CARRIER Total			**209**	**57,708**	**12,793**	**15**	**162**	**28%**	**1981**	**3.5**	**5.3**	**2.8**	**49.8**
CONTAINER SHIP	2	> 45,000	1	65,642	66,398	24	100	0%	1996	2.1	5.0	3.0	48.6
CONTAINER SHIP Total			**1**	**65,642**	**66,398**	**24**	**100**	**0%**	**1996**	**2.1**	**5.0**	**3.0**	**48.6**
TANKER	2	<30,000	66	19,231	8,852	15	183	88%	1983	3.4	5.0	2.4	28.1
		30,000 - 60,000	276	44,487	11,085	15	123	44%	1984	3.4	5.0	2.4	28.9
		60,000 - 90,000	161	76,375	15,241	15	99	0%	1984	3.3	5.0	3.0	32.3
		90,000 - 120,000	171	98,320	15,403	15	89	0%	1991	3.4	6.6	4.0	28.6
		120,000 - 150,000	31	139,846	21,270	15	85	0%	1987	3.4	6.6	4.0	67.7
		above 150,000	5	155,042	20,124	14	85	0%	1991	3.5	6.6	4.0	33.7
	4	<30,000	34	8,311	4,828	14	532	78%	1984	3.7	5.0	2.4	36.7
		30,000 - 60,000	24	43,869	15,369	16	ND	ND	1975	3.2	5.0	2.4	38.8
		60,000 - 90,000	27	77,584	14,563	15	275	50%	1983	3.4	5.0	3.0	49.1
	Steam Ship	<30,000	2	25,943	10,968	16	ND	ND	1954	3.2	5.0	2.4	30.4
		30,000 - 60,000	522	37,414	13,060	16	ND	ND	1957	3.2	5.0	2.4	26.1
		60,000 - 90,000	4	63,000	19,727	16	ND	ND	1971	3.1	5.0	3.0	31.2
		90,000 - 120,000	9	91,898	24,166	16	ND	ND	1977	3.1	6.6	4.0	29.8
TANKER Total			**1,332**	**53,948**	**13,178**	**15**	**128**	**24%**	**1974**	**3.3**	**5.3**	**2.7**	**29.9**
GENERAL CARGO	2	< 25,000	6	9,861	5,483	15	200	100%	1319	3.4	5.0	2.4	47.7
		25,000 - 35,000	1	31,900	15,140	16	ND	ND	1977	3.1	5.0	2.4	63.4
	4	< 25,000	4	11,672	6,015	15	425	100%	1980	3.5	5.0	2.4	54.6
	Steam Ship	< 25,000	1	22,536	23,673	21	ND	ND	1969	2.4	5.0	2.4	16.5
GENERAL CARGO Total			**12**	**13,357**	**8,480**	**16**	**313**	**100%**	**1649**	**3.3**	**5.0**	**2.4**	**48.7**
MISCELLANEOUS	2	ND	4	825	3,288	12	ND	ND	1980	4.2	5.0	2.4	54.7
	4	ND	1	1,375	5,480	14	ND	ND	1980	3.6	5.0	2.4	32.7
MISCELLANEOUS Total			**5**	**935**	**3,726**	**13**	**ND**	**ND**	**1980**	**4.0**	**5.0**	**2.4**	**50.3**
Grand Total			**1,561**	**53,947**	**13,124**	**15**	**133**	**25%**	**1973**	**3.3**	**5.3**	**2.8**	**32.8**

SECTION 11

PORT OF TAMPA, FL

11.1 DATA

Data were received from the Tampa MEPA (Reference 11-1) for all commercial vessels that called in the waterways covered by the MEPA for calendar year 1996. Assistance on time in mode and normal vessel operations was received from the Tampa Pilotage Authority (Reference 11-2). Commercial vessels calling on the public docks in the Bay area are included in the MEPA records.

The USACE port/waterway included in the MEPA data are listed in Table 11-1.This port had vessel traffic reported to USACE in 1995. The following port/waterways may also be within the region reported by the MEPA, but were not included in Table 11-1 because they had no reported commercial marine traffic in 1995: Tampa Channel Access, FL; Old Tampa Bay, FL; and Gulf at Tampa Harbor, FL. More detailed port information is available in Appendix B.6.

Table 11-1. Typical Ports within the Tampa MEPA dataset

DSP Rank	Typical Port	USACE Port Code
11	Tampa Harbor, FL	2021

The dataset received from the MEPA contains the information on the vessel name, ship-type, and flag; date and time or arrival and departure from the first and subsequent berths, and other information as shown in Appendix A, Table A-9.

Data received from the Tampa MEPA had no LRNs for any of the vessels. Out of the 7,148 records received from the MEPA which described an arrival or a shift, 3,251 were matched with LMIS data. This data set also included data on 2,291 barge arrivals/shifts. Barges and most tugs are not usually registered with LMIS and as such, do not have LMIS ship-type characteristic data in Table 11-6. The data which were matched, were matched by comparing ship name, ship-type, and flag between the MEPA and LMIS data. The best effort was made to match by ship-type, however, there is some room for error in this process. Each record describes a call on a berth or anchorage and is designated as either "arr" for the first berth upon arrival or "sft", for a subsequent and possibly last berth visited.

Table 11-6, located at the end of this section, is a summary table of all the vessels recorded by the MEPA in 1996 presented by ship-type, engine type, and DWT range. Ship-types were those given in the Lloyds data except that similar categories were grouped together for simplicity. Table 11-2 gives the number of calls per ship-type for calendar year 1996.

A call is one entrance and one exit from the entire area reported by the Tampa MEPA. Some vessel types are rarely, if ever, reported by the MEPA. These vessels include private vessels, fishing boats, and military vessels. There were a few dredgers, ferries, supply, maintenance, research, and fishing vessels recorded in the database. These are grouped into the "miscellaneous" category. There is some barge and tug data in the database which may be useful for characterizing the behavior of those ship-types. Table 11-2 lists the MEPA calls by ship-type for the Port of Tampa.

Table 11-2. Calls and shifts by ship-type as recorded by the MEPA for the Port of Tampa

Ship-type	Calls	Shifts	% dry-cargo calls [a]
Dry-cargo BARGE	525	367	NA
LIQUID CARGO BARGE	852	547	NA
BULK CARRIER	558	361	49.3%
CONTAINER SHIP	4	5	0.3%
GENERAL CARGO	342	71	30.2%
MISCELLANEOUS	18	10	NA
PASSENGER	120	12	10.6%
REEFER	54	2	4.8%
RORO	44	31	3.9%
TANKER	483	192	NA
TUG	1,326	1,183	NA
UNSPECIFIED MOTOR	8	30	0.7%
VEHICLES CARRIER	2	1	0.2%
Grand Total	**4,336**	**2,812**	**100.0%**

[a] Percent dry-cargo calls do not include trips for dry-cargo barge, liquid cargo barge, tanker, tug or miscellaneous ship-types

Table 11-3 presents a summary of trips for the USACE waterway codes that are included in the Tampa MEPA database by ship-type. There is some discrepancy in ship-types between the USACE and the MEPA matches with LMIS. Fishing vessels are not a separate category recognized by the USACE. The "miscellaneous" vessels in the MEPA database may correspond with some of the "other" vessels in the USACE database, but more data is needed before emissions can be estimated for the vessels in these categories. The totals of USACE ship-type trips in Table 11-3 can be used with the methodology in Section 4 to determine calls by ship-type for each Typical Port within the Tampa MEPA Area.

Table 11-3. USACE trips by ship-type for each USACE port/waterway in the Tampa MEPA dataset

Typical Port		Ship-Type [a,b]									Total Trips
Rank	Name	BC	CS	GC	PA	RF	RO	TA	VC	UC	
11	Tampa Harbor	958	32	229	96	238	64	974	2	534	3,127

[a] BC = Bulk Carrier, CS = Container Ship, GC = General Cargo, PA = Passenger, RF = Reefer, RO = RORO, TA = Tanker, VC = Vehicle Carrier, UC = Unspecified Dry-cargo,
[b] Trip totals do not include intraport movements (vessel movements within the same USACE port/waterway)

For purposes of determining MEPA calls for each Typical Port, we suggest allocating the UC trips in Table 11-3 over the dry-cargo ship-types using the percent of dry-cargo calls presented in Table 11-2. For example, the Port of Tampa has 534 UC trips. According to Table 11-2, BC trips are 49.3% of the dry-cargo calls for Tampa, and 49.3% of 534 is 263. Thus the total revised BC trips for Tampa would be 1,221 trips. This same process should be followed for all the ship-types within the Typical Port. This method of allocating the undefined ship-type trips is the default method. Any data available from the port or other reliable source that indicates a more refined allocation of UC ship-types trips should be used in place of the above method. The number of USACE recorded trips for tugs, dry-cargo barges, and liquid cargo barges are reported in Table 11-4 for purposes of comparison to the data reported by the Tampa MEPA in Table 11-2.

Table 11-4. USACE tug and barge trips as recorded by the USACE for the Port of Tampa

Typical Port		Ship-Type [a]			Total
Rank	Name	TUG	BD	BL	Trips
10	Tampa Harbor	2,369	1,134	1,312	4,815

[a] TUG = tugboat, BD = Barge, dry-cargo, BL = Barge, liquid cargo

11.2 TIME-IN-MODE CALCULATIONS

Descriptions of time-in-mode are given in Section 3, Table 3-1 of this report. The following descriptions are specific to calculations for the Port of Tampa. It is important to note that there are periods of acceleration and deceleration within each time-in-mode and that emissions may be over- or underestimated if a steady-state speed and load are assumed over the following time-in-modes.

11.2.1 Cruise

Cruise speed is the average continuous speed of the vessel in open water. Cruise is treated as the thirty-five miles from Egmont Key and continuing for twenty-five miles toward Egmont Key. Cruise is calculated over the same distance for the outbound leg of the call. Cruise time for each call on the MEPA Area was calculated using Equation 11.1.

Cruise = 25 / [Vessel Speed (knots)] *2 **(11.1)**

11.2.2 Reduced Speed Zone

Reduced speed zone (RSZ) time is the time the vessel is at a speed less than full cruise and greater than the 4 knot average used for maneuvering. Vessels begin to slow approximately 10 miles before Egmont Key. The pilot is picked up approximately 6 miles from Egmont Key. The following average times from the pilot boarding the vessel to the first line being made fast at the dock are listed in Table 11-5 for the indicated berths. The average speeds during the RSZ are 8-10 knots. Most berths in the Port of Tampa are approximately 30 miles from the pilot pick-up point and most vessels therefore have almost 30 miles of RSZ time-in-mode. One exception are the small reefer berths at Berths 210-211 which are approximately 22 miles from the pilot pick-up.

Table 11-5. Average time and distance from pilot pick-up near Egmont Key to specific berths in the Port of Tampa

Berth Numbers and Locations	Approx. Distance RSZ	Average Time (hr)
Berth 31, Pendola Point and Berths 1-4, Port Sutton	29	3.3
Berths 21 through 24B, Pendola Point	33	3.2 - 3.8
Berths 200-211, Upper East Bay, Hooker's Point	32	3.2 - 3.8
Smaller reefer ships, Berths 210 - 211	22	2.2
Berths 219-232, Hooker's Point	30	3 - 3.5
Berths 250-256 Hooker's Point and Berths 263-273 Downtown	34	3.5

11.2.3 Maneuvering

On the average, maneuvering starts two nautical miles from the dock and continues at speeds of 2-4 knots until the vessel is tied up. This is repeated as the vessel is leaving the port for an average time-in-mode per call on each berth of 1 hour. Anchorages take less time to maneuver into and are allotted 0.3 hours in and 0.3 hours out for a total time in mode per anchorage of 0.6 hours. As most shifting takes place between berths that are less than 4 miles apart and/or in heavily trafficked areas, time-in-mode for shifts is considered to be maneuvering at an average speed of 4 knots.

$$\textbf{Maneuver (hr/call)} = 1 + \sum \text{shift(hr)} \quad (11.2)$$

$$\textbf{shift(hr)} = [(\text{PORTATA at berth n}\} - (\text{PORTATD from berth n-1})] \quad (11.3)$$

11.2.4 Hotelling

Hotelling occurs when the vessel is at anchorage or at a berth and is the sum of the times spent at each berth in the Port of Tampa. In Equation 11.4, the dates and times are for arrival and departure at each berth; n equals 1 for the first berth and continues to increment by 1 until n equals the number of shifts for that particular vessel for that particular call on the MEPA Area.

$$\textbf{Hotelling (hr/call)} = \sum[(\text{Departure\_Date}_n - \text{Arrival\_Date}_n) * 24 + (\text{Departure\_Time} - \text{Arrival\_Time}_n)] \quad (11.4)$$

11.2.5 Summary Table

The summary table, Table 11-6, reflects all of the ship-types, vessel characteristics, and time-in-mode data available for the Port of Tampa. There are some ship-type categories for which one or more of the data fields had no available data. This is most commonly seen for all of the LMIS ship characteristics for tugs and barges. Tugs and barges are not regularly required to register with LMIS. There is a large standard deviation for many of the hotelling totals as a few vessels that stayed in port for repairs, retrofit or some other reason had hotelling times in the hundreds or thousands of hours. If one of these long hotelling times occurs for a ship-type category that only have a few calls, the average hotelling time will appear much higher than may actually be typical. In these cases, we recommend using the average hotelling time for the entire ship-type.

11.3 DATA QUALIFIERS

Many fields did not have data for all records but the most important fields showing dates, times, ship-type, and ship name were more complete. The absence of LRNs from the MEPA data introduced the possibility for more substantial errors in the LMIS data matching process than was existent for the other ports. After calculating RSZ, maneuvering, and hotelling times for each call and shift, a visual inspection of the results was performed. Data that had negative times or excessively large times for any of the time-in-modes were examined for obvious inconsistencies. If an obvious inconsistency was found such as an arrival or departure date with a year other than 1996 (or in some very few cases, January of 1997) the year was changed to the appropriate year. Another somewhat common error was a departure time late in the day and an arrival time at the next berth early in the same day. In this case, the day of arrival was increased by one day to account for the change past midnight. In some cases the error was due to an empty field.

If fields were missing and an informed guess could not be made as to its value, the record was excluded from the time-in-mode calculations, but its ship-type characteristics were still included in those averages in Table 11-6. Likewise, vessels that did not have ship-type characteristics were still included in the time-in-mode calculations.

Therefore, for some time-in-mode or ship-type characteristic fields in Table 11-6 there is an entry of ND meaning that no data were available. If a significant number of time-in-modes were encountering similar errors, the pilot's association of the MEPA was contacted to get information on why these calculations might be incorrect.

Tug assistance will affect the time-in-mode for a vessel. A vessel coming to anchor will not require tug assistance. A dry-cargo vessel docking at a berth will virtually always require tug assistance and will meet the tug approximately two miles from the destination berth. All vessels are under their own power even when docking with tug assistance. The main propulsion engines may be in neutral during the final stages of docking, but they are not shut down until the vessel is secured at the dock or anchorage.

Tugs and barges are included in Table 11-6. Lacking other data, the calculations for time-in-modes of these vessels were carried out as described in Section 11.2. However, it is very likely that these vessels do not have the same movement characteristics as deep-sea vessels. For example, tugs and barges are not believed to regularly enter or clear the breakwater or to pick-up a pilot near Egmont Key and tugs are not expected to spend long periods of time hotelling at a berth. Instead, tugs are expected to be in almost constant motion throughout the day with very little hotelling or time when the main propulsion engines are shut-down.

Table 11-6: Summary of 1996 Deep-Sea Vessel Data for the Port of Tampa, FL

Ship-type	Engine Type	DWT RANGE	Calls	Shifts	DWT (tonnes)	Power (HP)	Vessel Speed (knots)	Engine Speed (RPM)	% RPM >130	Date of Build	Cruise (hr/call)	RSZ (hr/call)	Man. (hr/call)	Hotel (hr/call)
BULK CARRIER	2	<25,000	52	23	18,828	8,478	15	158	56%	1979	3.4	5.6	1.9	76.2
		25,000 - 35,000	82	63	29,575	9,367	15	125	32%	1983	3.4	5.5	2.8	87.4
		35,000 - 45,000	66	50	39,389	10,670	15	114	14%	1983	3.4	5.4	2.7	96.1
		> 45,000	117	139	57,952	13,451	15	110	0%	1979	3.4	5.4	3.4	71.9
	4	<25,000	8	2	15,900	6,581	14	ND	ND	1975	3.5	5.5	1.4	346.8
		25,000 - 35,000	2	2	29,089	8,198	14	157	100%	1995	3.6	5.4	3.3	64.6
		35,000 - 45,000	1	1	41,455	11,336	14	117	0%	1995	3.6	5.3	3.0	223.2
	Steam Turbine	> 45,000	1	2	92,854	ND	16	ND	ND	1975	3.1	5.3	9.0	265.3
	ND	ND	229	79	ND	ND	ND	ND	ND	ND	ND	5.4	1.5	56.3
BULK CARRIER Total			**558**	**361**	**39,830**	**10,876**	**15**	**124**	**23%**	**1981**	**3.4**	**5.4**	**2.3**	**75.6**
CONTAINER SHIP	2	35,000 - 45,000	2	4	36,750	23,945	21	ND	ND	1986	2.4	5.7	3.3	276.3
		> 45,000	1	ND	60,639	51,920	24	90	0%	1990	2.1	5.3	1.0	7.1
	4	<25,000	1	1	21,540	16,993	20	428	100%	1993	2.5	4.4	3.0	125.9
CONTAINER SHIP Total			**4**	**5**	**38,920**	**29,201**	**22**	**259**	**50%**	**1989**	**2.3**	**5.3**	**2.6**	**171.4**
GENERAL CARGO	2	<15,000	37	15	6,769	4,048	14	197	100%	1979	3.7	5.5	1.8	46.2
		15,000 - 30,000	22	7	21,512	9,736	16	130	50%	1982	3.2	5.8	1.4	80.8
		30,000 - 45,000	2	ND	34,336	10,300	15	95	0%	1980	3.5	5.7	1.0	43.5
		> 45,000	1	2	46,641	8,950	15	105	0%	1995	3.3	5.3	5.7	120.8
	4	<15,000	70	17	3,158	2,322	13	554	100%	1978	3.9	5.8	1.2	98.7
		15,000 - 30,000	5	2	19,880	10,120	15	ND	ND	1981	3.5	5.9	1.7	51.4
	Steam Turbine	<15,000	14	10	14,897	ND	19	ND	ND	1966	2.6	5.4	1.2	35.7
	ND	ND	191	18	ND	ND	ND	ND	ND	ND	ND	5.8	1.2	62.3
GENERAL CARGO Total			**342**	**71**	**9,060**	**4,428**	**14**	**280**	**86%**	**1978**	**3.6**	**5.8**	**1.3**	**68.0**
PASSENGER	2	<5,000	26	3	4,243	29,370	21	ND	ND	1984	2.4	6.0	1.1	15.1
		5,000 - 10,000	55	ND	6,456	29,961	19	120	0%	1984	2.6	6.0	1.0	10.2
	4	<5,000	5	4	1,254	9,313	17	769	100%	1979	3.0	6.0	1.8	224.3
		5,000 - 10,000	2	ND	5,500	20,934	18	580	100%	1987	2.8	6.0	1.0	9.5
	ND	ND	32	5	ND	ND	ND	ND	ND	ND	ND	6.0	1.0	71.8
PASSENGER Total			**120**	**12**	**5,485**	**28,408**	**20**	**559**	**75%**	**1984**	**2.5**	**6.0**	**1.0**	**36.6**
REEFER	2	5,000 - 10,000	46	1	6,417	8,160	18	158	70%	1986	2.8	4.0	1.0	38.8
		10,000 - 15,000	6	1	11,054	12,983	20	120	0%	1976	2.6	3.5	5.0	352.4
	4	<5,000	1	ND	3,536	3,002	14	600	100%	1978	3.6	3.5	1.0	86.2
		5,000 - 10,000	1	ND	6,502	6,933	16	168	100%	1995	3.1	3.5	1.0	81.8
REEFER Total			**54**	**2**	**6,880**	**8,578**	**18**	**168**	**70%**	**1985**	**2.8**	**3.9**	**1.5**	**75.3**
RORO	2	<5,000	30	23	872	1,948	14	ND	ND	1959	3.6	5.6	2.0	60.3
	4	<5,000	12	5	2,697	2,849	13	750	100%	1977	3.9	6.0	1.5	216.1
		5,000 - 10,000	2	3	7,440	9,000	15	600	100%	1993	3.3	6.0	1.5	199.9
RORO Total			**44**	**31**	**1,668**	**2,514**	**14**	**650**	**100%**	**1966**	**3.7**	**5.8**	**1.9**	**110.3**

Table 11-6: Summary of 1996 Deep-Sea Vessel Data for the Port of Tampa, FL

Ship-type	Engine Type	DWT RANGE	Calls	Shifts	DWT (tonnes)	Power (HP)	Vessel Speed (knots)	Engine Speed (RPM)	% RPM >130	Date of Build	Cruise (hr/call)	RSZ (hr/call)	Man. (hr/call)	Hotel (hr/call)
TANKER	2	<30,000	111	24	19,007	11,871	16	136	47%	1978	3.1	5.5	1.3	34.3
		30,000 - 60,000	17	10	39,778	16,976	17	122	0%	1977	3.0	5.5	1.7	37.0
	4	<30,000	45	15	3,121	1,542	11	459	100%	1972	4.5	5.6	1.4	86.0
		30,000 - 60,000	3	4	37,874	16,000	16	ND	ND	1971	3.1	5.4	1.8	35.9
	Steam Turbine	<30,000	37	2	24,854	ND	14	ND	ND	1947	3.5	5.7	1.1	21.1
		30,000 - 60,000	121	110	37,075	ND	15	ND	ND	1955	3.3	5.4	1.9	47.7
		> 150,000	1	2	228,274	ND	17	ND	ND	1977	2.9	6.0	2.4	640.7
	ND	ND	148	25	ND	ND	ND	ND	ND	ND	ND	5.4	1.2	21.9
TANKER Total			**483**	**192**	**25,893**	**9,794**	**15**	**150**	**44%**	**1966**	**3.4**	**5.5**	**1.4**	**39.0**
TUG	2	ND	701	687	75	4,905	12	ND	ND	1976	4.3	5.4	2.1	55.7
	4	ND	166	125	157	9,206	14	ND	ND	1978	3.7	5.6	2.1	64.9
	ND	ND	459	371	ND	ND	ND	ND	ND	ND	ND	5.5	1.6	49.6
TUG Total			**1,326**	**1,183**	**91**	**5,768**	**13**	**ND**	**ND**	**1976**	**4.2**	**5.4**	**1.9**	**54.7**
VEHICLES CARRIER	2	12,500 - 15,000	2	1	13,208	11,500	18	111	0%	1984	2.8	5.7	1.3	203.3
VEHICLES CARRIER Total			**2**	**1**	**13,208**	**11,500**	**18**	**111**	**0%**	**1984**	**2.8**	**5.7**	**1.3**	**203.3**
BARGE DRY CARGO	ND	ND	525	367	ND	ND	ND	ND	ND	ND	ND	5.4	1.8	91.8
BARGE DRY CARGO Total			**525**	**367**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**	**5.4**	**1.8**	**91.8**
BARGE TANKER	ND	ND	852	547	ND	ND	ND	ND	ND	ND	ND	5.5	2.0	149.6
BARGE TANKER Total			**852**	**547**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**	**5.5**	**2.0**	**149.6**
MISCELLANEOUS	2	<1,000	4	2	113	895	12	ND	ND	1977	4.2	5.9	1.1	83.5
		5,000 - 10,000	1	ND	9,360	10,332	18	ND	ND	1984	2.8	3.5	1.0	319.7
	4	1,000 - 5,000	1	ND	2,389	1,320	10	ND	ND	1979	5.0	5.3	1.0	130.0
		<1,000	4	3	342	2,129	12	ND	ND	1980	4.2	5.4	1.8	906.4
		5,000 - 10,000	1	ND	7,040	5,998	16	430	100%	1985	3.1	3.5	1.0	109.8
	ND	ND	7	5	ND	ND	ND	ND	ND	ND	ND	6.0	1.2	922.4
MISCELLANEOUS Total			**18**	**10**	**1,873**	**2,704**	**13**	**430**	**100%**	**1980**	**4.0**	**5.5**	**1.3**	**609.8**
UNSPECIFIED MOTOR	ND	ND	8	30	ND	ND	ND	ND	ND	ND	ND	5.5	2.2	999.5
UNSPECIFIED MOTOR Total			**8**	**30**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**	**5.5**	**2.2**	**999.5**
Grand Total			**4,336**	**2,812**	**12,921**	**8,325**	**14**	**182**	**48%**	**1976**	**3.6**	**5.5**	**1.8**	**84.4**

SECTION 12

PORT OF BALTIMORE, MD

12.1 DATA

Data were received from the Maryland MEPA (Reference 12-1) for all commercial vessels that called in the waterways covered by the MEPA for calendar year 1996. Assistance on time-in-mode and normal vessel operations was received from the Baltimore MEPA (Reference 12-2). The data set provided by the MEPA includes berths along the Patapsco River from Fort Howard up to and including Baltimore's Inner Harbor and also includes anchorages at Annapolis if those vessels also docked at Baltimore.

The USACE port/waterway area covered in the MEPA data are listed in Table 12-1. Although the port/waterway areas of Bodkin Creek, Middle River, and Northeast River, may also be included in the MEPA waterway area, there are no records of vessel trips to these waterways in either the USACE or Census Bureau databases for 1995. More detailed port descriptions are available in Appendix B.7.

Table 12-1. Typical Ports within the Maryland MEPA dataset

DSP Rank	Typical Port	USACE Port Code
16	Baltimore Harbor and Channels, MD	700

The dataset received from the MEPA contains the information on the vessel name; ship type; time the vessel entered and cleared the breakwater; anchorage, date at anchor, time at anchor, and time up; first and subsequent berths; date of shifting; and other information as shown in Appendix A, Table A-10. Data received from the MEPA had LRNs for most of the ships. Out of 2,080 records, 1,896 had valid LRNs. The remaining ships were matched with LRNs by comparing ship name, ship-type, and DWT provided by the MEPA with LMIS data. If no LRN was available with ship name identical to the one in the MEPA database, a similar ship name with the same ship-type and similar DWT was selected.

There is some room for error in this process, but the use of ship-type and DWT categories in the summary tables provide enough leeway to reduce the impact of small errors in the matching process. Seventy-two records did not have date and time information or valid LMIS numbers and were therefore excluded from Table 12-5. Many of the seventy-two excluded records were for military vessels. Therefore 2,007 records are used in Table 12-5 to define vessel characteristics and time-in-mode. The MEPA does not record vessels that are just passing by Baltimore and not docking.

Table 12-5 (located at the end of this section) is a summary table of all the vessels recorded by the MEPA in 1996 presented by ship-type, engine type, and DWT range. Ship-types were those given in the Lloyds data except that similar categories were grouped together for simplicity. Table 12-2 gives the number of calls per ship-type for calendar year 1996. A call is one entrance and one clearance from the entire area reported by the Maryland MEPA. Some vessel types are rarely, if ever, recorded by the MEPA. These vessels include ferries, tugs, barges, supply vessels, yachts, fishing vessels, and excursion vessels. There are two of these irregularly recorded ship-types in the 1996 data. Two cable layers and one supply vessel are grouped together in a "miscellaneous" category.

Table 12-2. Calls and shifts by ship-type as recorded by the Maryland MEPA

Ship-Type	Calls	Shifts	% dry-cargo calls [a]
BULK CARRIER	481	245	26.6%
CONTAINER SHIP	541	38	30.0%
GENERAL CARGO	226	75	12.5%
MISCELLANEOUS	10	6	NA
PASSENGER	15	0	0.8%
REEFER	2	1	0.1%
RORO	250	90	13.8%
TANKER	147	63	NA
TUG [b]	42	13	NA
VEHICLES CARRIER	293	172	16.2%
Grand Total	**2,007**	**703**	**100.0%**

[a] Percent dry-cargo calls do not include trips for tanker, tug or miscellaneous ship-types
[b] Tugs are only partially recorded by the MEPA

Table 12-3 presents a summary of USACE trips by ship-type for the Typical Ports that are within the Maryland MEPA database. There is some discrepancy in ship-types between the USACE and the MEPA matches with LMIS. For instance, fishing vessels are not a separate category recognized by the USACE. The "miscellaneous" vessels in the MEPA database may correspond with some of the "other" vessels in the USACE database, but more data is needed before emissions can be estimated for the vessels in these categories. The USACE trip totals in Table 12-3 should be used with the methodology in Section 4 to determine calls by ship-type for each Typical Port within the Maryland MEPA Area.

Table 12-3. USACE trips by ship-type for each Typical Port within the Maryland MEPA

Typical Port		Ship-Type [a, b]									Total Trips
Rank	Name	BC	CS	GC	PA	RF	RO	TA	VC	UC	
16	Baltimore Harbor	806	966	208	32	4	507	309	398	1,097	4,327

[a] BC = Bulk Carrier, CS = Container Ship, GC = General Cargo, PA = Passenger, RF = Reefer, RO = RORO, TA = Tanker, VC = Vehicle Carrier, UC = Unspecified Dry-cargo,

[b] Trip totals do not include intraport movements (vessel movements within the same USACE port/waterway)

For purposes of allocating the USACE data to the MEPA data, we suggest allocating the UC trips in Table 12-3 over the dry-cargo ship-types using the percent of dry-cargo calls presented in Table 12-2. For example, Baltimore Harbor, has 1,097 UC trips. According to Table 12-2, BC trips are 26.6% of the dry-cargo calls for the entire MEPA Area, and 26.6% of 1,097 is 292. Thus, the total revised BC trips for Baltimore Harbor would be 1,098 trips. This same process should be followed for all the ship-types within the Typical Port. This method of allocating the undefined ship-type trips is the default method. Any data available from the port or other reliable source that indicates a more refined allocation of UC ship-types trips should be used in place of the above method.

12.2 TIME-IN-MODE CALCULATIONS

Vessels docking at Baltimore Harbor have two ways of coming from the open ocean. The first and most common is the southern entrance of the Chesapeake Bay at Cape Henry. Cape Henry is 155 nautical miles from Baltimore and average speed in the lower Chesapeake Bay is 15 knots with the last 10 miles at a more reduced speed. The northern entrance is at the Chesapeake and Delaware Ship Canal (C&D Canal) which connects the Chesapeake Bay to the Delaware River. Chesapeake City, at the Chesapeake side of the C&D Canal, is 60 miles from Baltimore and the average speed in the upper Bay is 12 knots, again with the last 10 miles at a reduced speed.

The average time to traverse this distance is included in the RSZ time for each vessel calling on Baltimore Harbor. It takes approximately 9.7 hours to reach North Point from Cape Henry and 4.2 to reach North Point from Chesapeake City. Once North Point is reached, the vessel picks up the harbor pilot and continues at a reduced speed of approximately 7 knots until the vessel is within 2 miles of the intended berth and then slows to dead-slow maneuvering speed of approximately 4 knots.

Average times to get to the first berth or anchorage from North Point are given in Table 12-4. Descriptions of time-in-mode are given in Section 3, Table 3-1 of this report. The following descriptions are specific to calculations for Delaware River ports.

Table 12-4. Average time to berth or anchorage for the Ports off the Patapsco River

Port	Nautical miles from North Point	Average Time (hr)
Dundalk Marine Terminal	5.6	0.8
Atlantic Marine Terminal	6.6	0.9
North Locust Point Marine Terminal	8.6	1.2
South Locust Point Marine Terminal	8.3	1.2
Lazaretto Point	8.1	1.2
Sea-Land Service, Seagirt Terminal Wharf	6.9	1.0
Sparrow's Point	2.3	0.3
Inner Harbor	10.1	1.4

12.2.1 Cruise

Cruise speed is the average continuous speed of the vessel in open water. Cruise is treated as beginning twenty-five miles out from the breakwater at Cape Henry and is calculated by dividing 25 miles by the service speed of the vessel times two to account for round-trip. For vessels leaving or entering by the C&D Canal, using 25 miles at cruise has no physical meaning. These vessels will continue at the 10 to 15 knot controlling speed in the Canal for 13 miles until reaching the exit at Reedy Point and then at the approximately 12 to 18 knot controlling speed in the Delaware River for 50 miles before reaching open ocean at the Delaware Capes. Equation 12.1 was used to determine cruise time for all calls on the MEPA Area.

$$\textbf{Cruise} = 25 / [\textbf{Vessel Speed (knots)}] * 2 \qquad \textbf{(12.1)}$$

12.2.2 Reduced Speed Zone

The reduced speed zone for vessels calling on Baltimore Harbor has two fairly distinct phases. The first phase occurs at Point Lookout or Chesapeake City (depending on whether the ship is coming from open ocean or the C&D Canal respectively) when the Maryland Pilot boards. The vessel then continues at service speed or a reduced speed as described in the introduction to Section 12.2 above. The time to traverse the C&D Canal or the time spent in the Delaware River is not included in the RSZ time-in-mode for Baltimore Harbor. The second phase occurs just before the harbor pilot boards at North Point and averages 7 knots until the vessel is within two miles of the first berth or anchorage. The same two phases are repeated on the way back to open ocean for a time-in-mode described by:

RSZ = RSZin + RSZout + RSZharin + RSZharout **(12.2)**

RSZin = 145/Sl or 50/Su **(12.3)**

RSZout = 145/Sl or 50/Su **(12.4)**

RSZharin = (Df-2)/7 **(12.5)**

RSZharout = (Dl-2)/7 **(12.6)**

Where:

145 = miles from Point Lookout to North Point minus 5 miles for slowing to pick up the pilot

Sl = controlling speed in the lower bay, either service speed or 15 knots, whichever is slower

50 = miles from C&D Canal to North Point minus 5 miles for slowing to pick up pilot

Su = controlling speed in the upper bay of 12 knots

Df = distance from North Point to the first berth minus 2 miles for maneuvering

Dl = distance from the last berth to North Point minus 2 miles for maneuvering

12.2.3 Maneuvering

On the average, maneuvering starts 1-2 nautical miles from the dock and continues until the vessel is tied up. This is repeated as the vessel is leaving the port for an average time in mode per call of 1 hour.

Vessel shifts between nearby docks or anchorages usually occur at maneuvering speeds with a 4 knot average. Therefore, vessels that call on more than one berth or anchorage may have maneuvering times that are longer or shorter than 1 hour for each berth and 0.5 hour for each anchorage as there will often be more or less than 4 miles between shifting berths.

Maneuvering (hr/call) = 1+ shift(hr) **(12.7)**

Shift (hr) = D/4 **(12.8)**

Where:

D = Nautical miles between previous berth/anchorage and destination berth/anchorage

12.2.4 Hotelling

Hotelling occurs when the vessel is at anchorage or at a berth and is the total time in port minus the time-in-mode for RSZ and maneuvering.

Hotelling (hr/call) = (NPT_OU_DAT - A_DATE) * 24 + (NPT_OUT_TI - NPT_TIME) - Maneuver - RSZ **(12.9)**

Where:

NPT_OUT_DAT	= the date clearing North Point
A_DATE	= the date arriving at North Point
NPT_OUT_TI	= the time the vessel clears North Point
NPT_TIME	= the entrance time at North Point

12.3 DATA QUALIFIERS

Many fields did not have data for all records but the most important fields showing dates, times, ship-type, and ship name were mostly complete. After calculating each time-in-mode for each call and shift, a visual inspection of the results was performed. Data showing negative times or excessively large times for any of the time-in-modes were examined for obvious errors. If an obvious inconsistency was found such as an arrival or departure date with a year other than 1996 (or in some very few cases, January of 1997) the year was changed to the appropriate year. Another somewhat common error would be a departure time late in the day and an arrival time at the next berth early in the same day. In this case, the day of arrival was increased by one day to account for the change past midnight. In some cases the error was due to an empty field.

If a date field was empty and an accurate guess could be made to the date, a date was entered. If a time was missing, the estimated time of arrival or departure was used rather than the actual date or time. If these estimated times were not available, the record was excluded from the time-in-mode calculations, but its ship-type characteristics were still included in those averages in Table 12-5. Therefore, for some time-in-mode or ship-type characteristic fields in Table 12-5, there is an entry of ND meaning that no data were available. If a significant number of time-in-mode calculationss were encountering similar errors, the pilot's association of the MEPA was contacted to get information on why these calculations might be incorrect.

Tug assistance will affect the time in mode for a vessel. A dry-cargo vessel docking at a berth will nearly always require tug assistance and will meet the tug at the entrance to the harbor area . Tug assist occurs at dead slow or reverse and is treated in these calculations as occurring at 4 knots. A vessel coming to anchor will not require tug assistance and is expected to have a maneuvering time of 0.5 hours total for the each anchorage. All vessels are under their own power even when docking with tug assistance. The main propulsion engines may be in neutral during the final stages of docking, but they are not shut down until the vessel is secured at the dock or anchorage.

The RSZ time for vessels entering and leaving the Chesapeake Bay by the C&D Canal could be more accurately estimated by including the time in the C&D Canal and the time in the Delaware River in the RSZ time. There will be some vessels that use the C&D Canal that are not recorded by either the Maryland MEPA or the Philadelphia MEPA. Vessels using a southern approach to Delaware River Ports often use the

Chesapeake Bay and the C&D Canal rather than enter the Delaware River by the Delaware Capes. Unless the vessel has a federal pilot, a pilot from the Association of Maryland Pilots will be required for navigation in the Bay and records of the vessels that use Maryland Pilots but do not dock at Baltimore may be available. The knowledge of what ships enter and clear the C&D Canal would allow a more accurate estimation of emissions from the Delaware River Ports. Twenty-two to thirty percent of the vessels calling on Baltimore Harbor in 1996, or approximately 500 vessels, entered or cleared the C&D Canal. Five hundred vessels is approximately 20% of the total vessel traffic in the Delaware River and its omission could have a significant effect on air estimate emissions.

Table 12-5: Summary of 1996 Deep-Sea Vessel Data for Baltimore Harbor, MD

Ship Type	Engine Type	DWT Range	Calls	Shifts	DWT (tonnes)	Power (hp)	Vessel Speed (knots)	Engine Speed (RPM)	%RPM >130	Date of Biuld	Cruise (hr/call)	RSZ (hr/call)	Maneuver (hr/call)	Hotel (hr/call)
BULK CARRIER	2	< 25,000	50	27	18,690	8,707	15	146	63%	1981	3.4	16.0	1.5	113.5
		25,000 - 35,000	85	52	29,958	10,618	15	131	61%	1982	3.3	16.7	1.5	167.7
		35,000 - 45,000	73	43	39,143	10,435	15	109	5%	1984	3.4	16.6	1.6	133.1
		45,000 - 90,000	144	75	68,715	13,970	14	100	3%	1986	3.5	17.4	1.5	79.1
		> 90,000	76	40	133,223	18,241	14	86	0%	1985	3.5	18.9	1.4	49.5
	4	< 25,000	10	4	12,466	5,700	14	ND	ND	1974	3.7	14.7	1.5	63.6
		25,000 - 35,000	3	2	32,322	8,602	13	157	100%	1984	4.0	20.1	1.3	181.8
		45,000 - 90,000	3	0	89,127	12,600	14	404	100%	1982	3.6	17.5	1.3	91.0
		> 90,000	2	2	158,526	17,850	14	399	100%	1986	3.6	17.2	2.5	64.7
	Steam Turbine	< 25,000	29	0	18,232	9,115	15	ND	ND	1975	3.3	14.2	1.3	30.3
		25,000 - 35,000	1	0	33,373	11,837	15	ND	ND	1983	3.3	10.7	1.3	1.2
		> 90,000	5	0	159,743	27,126	16	ND	ND	1970	3.1	17.2	1.3	61.4
BULK CARRIER Total			**481**	**245**	**59,304**	**12,611**	**15**	**111**	**16%**	**1983**	**3.4**	**17.0**	**1.5**	**98.8**
CONTAINER SHIP	2	< 25,000	247	21	21,107	18,352	19	118	16%	1987	2.6	14.1	1.3	23.7
		25,000 - 35,000	96	5	29,065	16,979	19	102	0%	1984	2.7	14.5	1.3	17.2
		35,000 - 45,000	92	8	39,319	46,221	23	105	0%	1979	2.2	16.9	1.4	16.1
		45,000 - 90,000	72	2	55,730	41,379	22	94	0%	1988	2.2	17.1	1.3	13.7
	4	< 25,000	13	1	8,793	6,508	16	475	100%	1984	3.2	13.4	1.3	105.4
	Steam Turbine	< 25,000	3	0	18,832	28,112	23	ND	ND	1973	2.2	14.1	1.3	12.7
		25,000 - 35,000	18	1	26,826	35,181	20	ND	ND	1973	2.5	15.5	1.3	20.7
CONTAINER SHIP Total			**541**	**38**	**30,106**	**26,242**	**20**	**117**	**10%**	**1985**	**2.5**	**15.1**	**1.3**	**21.7**
GENERAL CARGO	2	< 25,000	114	47	16,545	10,516	16	154	55%	1982	3.1	16.7	1.5	108.3
		25,000 - 35,000	13	6	30,370	10,302	15	108	0%	1984	3.3	16.5	2.0	96.8
		35,000 - 45,000	9	1	41,141	13,058	16	ND	ND	1984	3.1	14.3	1.3	29.8
		45,000 - 90,000	1	0	45,000	12,300	16	93	0%	1994	3.1	17.4	1.3	180.0
	4	< 25,000	80	19	5,301	3,469	13	642	100%	1988	3.8	19.0	1.4	55.7
		25,000 - 35,000	4	2	29,719	12,000	14	ND	ND	1974	3.6	18.0	2.1	107.2
	Steam Turbine	< 25,000	5	0	13,264	16,709	20	ND	ND	1962	2.6	17.4	1.3	358.9
GENERAL CARGO Total			**226**	**75**	**14,626**	**8,281**	**15**	**435**	**78%**	**1984**	**3.4**	**17.4**	**1.5**	**91.7**
Miscellaneous	2	< 10,000	4	2	6,450	3,500	15	ND	ND	1982	3.3	15.9	2.0	509.1
	4	< 10,000	6	4	7,053	11,671	14	720	100%	1990	3.5	18.3	1.8	790.1
Miscellaneous Total			**10**	**6**	**6,812**	**10,503**	**15**	**720**	**100%**	**1987**	**3.4**	**17.3**	**1.9**	**677.7**
PASSENGER	2	<10,000	3	0	6,291	22,000	20	ND	ND	1976	2.5	15.1	1.3	81.9
	4	<10,000	6	0	5,478	32,171	20	524	100%	1986	2.6	15.1	1.3	85.7
	Steam Turbine	<10,000	6	0	7,942	35,363	24	ND	ND	1961	2.1	16.1	1.3	146.7
PASSENGER Total			**15**	**0**	**6,626**	**31,413**	**21**	**524**	**100%**	**1974**	**2.4**	**15.5**	**1.3**	**109.4**
REEFER	2	10,000 - 20,000	2	1	11,560	13,100	19	117	0%	1987	2.6	10.9	1.6	531.4
REEFER Total			**2**	**1**	**11,560**	**13,100**	**19**	**117**	**0%**	**1987**	**2.6**	**10.9**	**1.6**	**531.4**

Table 12-5: Summary of 1996 Deep-Sea Vessel Data for Baltimore Harbor, MD

Ship Type	Engine Type	DWT Range	Calls	Shifts	DWT (tonnes)	Power (hp)	Vessel Speed (knots)	Engine Speed (RPM)	%RPM >130	Date of Biuld	Cruise (hr/call)	RSZ (hr/call)	Maneuver (hr/call)	Hotel (hr/call)
RORO	2	<10,000	66	30	5,420	9,650	16	96	0%	1981	3.1	17.1	1.5	47.8
		10,000 - 20,000	46	30	15,272	14,935	19	98	0%	1985	2.7	15.1	2.0	30.3
		20,000 - 30,000	51	28	26,522	16,952	20	102	0%	1984	2.6	14.6	1.9	32.6
		> 30,000	83	2	45,016	26,562	19	98	0%	1983	2.7	17.4	1.3	19.8
	4	<10,000	3	0	8,903	10,332	15	425	100%	1979	3.3	15.8	1.3	33.6
		20,000 - 30,000	1	0	24,106	27,000	22	ND	ND	1972	2.3	16.2	1.3	1301.3
RORO Total			**250**	**90**	**24,800**	**17,805**	**18**	**107**	**3%**	**1983**	**2.8**	**16.3**	**1.6**	**37.0**
TANKER	2	<30,000	53	24	19,174	8,165	14	157	52%	1984	3.5	15.6	1.6	34.3
		30,000 - 60,000	42	25	37,543	12,008	15	113	7%	1982	3.3	16.5	1.7	51.5
		60,000 - 90,000	13	2	64,867	14,170	15	108	0%	1985	3.3	15.9	1.4	34.3
		90,000 - 120,000	1	0	95,628	16,600	14	94	0%	1993	3.6	17.5	1.3	242.4
		> 150,000	1	1	281,559	29,460	15	75	0%	1995	3.3	17.2	2.3	93.3
	4	<30,000	22	5	8,330	5,354	14	486	100%	1989	3.5	14.5	1.5	29.1
		30,000 - 60,000	7	5	36,753	14,760	16	ND	ND	1983	3.2	16.8	1.7	39.0
	Steam Turbine	30,000 - 60,000	8	1	44,388	16,275	15	ND	ND	1958	3.3	18.1	1.3	30.9
TANKER Total			**147**	**63**	**31,354**	**10,331**	**15**	**222**	**46%**	**1983**	**3.4**	**15.9**	**1.6**	**40.3**
TUG	2	<10,000	15	2	177	4,713	13	900	100%	1975	4.0	16.6	1.3	52.9
	4	<10,000	27	11	430	15,252	16	750	100%	1978	3.2	14.9	1.4	29.3
TUG Total			**42**	**13**	**340**	**11,488**	**15**	**825**	**100%**	**1977**	**3.4**	**15.5**	**1.4**	**37.8**
VEHICLES CARRIER	2	<10,000	3	5	9,352	10,978	18	124	33%	1984	2.8	16.1	2.9	35.4
		10,000 - 20,000	225	118	14,660	13,308	18	110	0%	1985	2.7	14.7	1.8	22.8
		20,000 - 30,000	3	1	26,342	13,963	19	101	0%	1990	2.7	17.0	1.7	17.0
	4	<10,000	12	7	8,246	11,830	18	530	100%	1980	2.8	14.2	1.5	21.7
		10,000 - 20,000	50	41	12,863	13,649	18	502	100%	1981	2.8	15.5	1.9	28.1
VEHICLES CARRIER Total			**293**	**172**	**14,156**	**13,289**	**18**	**173**	**17%**	**1984**	**2.7**	**14.9**	**1.8**	**23.7**
Grand Total			**2,007**	**703**	**31,529**	**16,493**	**17**	**172**	**23%**	**1984**	**3.0**	**16.0**	**1.5**	**56.4**

SECTION 13

PORT OF COOS BAY, OR

13.1 DATA

Data were received from the MEPA of the Columbia River (Reference 13-1) for all commercial vessels that called in the waterways covered by the MEPA for calendar year 1996. Assistance on time-in-mode and normal vessel operations were received from the pilots at Coos Bay Pilot's Association (Reference 13-2). Ports and anchorages covered in the dataset are all within the port of Coos Bay as defined by the USACE in Table 13-1. Two other port/waterways, Coos Bay, OR (entrance) and Coos and Milicoma Rivers, OR, may also be part of the geographic region covered by the MEPA. However, USACE had no recorded trips or tonnages for those port/waterways in 1995. More detailed port information is available in the Appendix B.8.

Table 13-1. Typical Ports within the MEPA of the Columbia River's dataset

DSP Rank	Typical Port	USACE Port Code
56	Coos Bay, OR	4660

The dataset received from the MEPA contains the information on the vessel name, arrival date and time, departure date and time, cargo type, and other information as shown in Appendix A, Table A-11. No data were included on the arrival or departure berth or on any berths, dates, times or other indicator associated with shifting.

Data received from the MEPA of the Columbia River had LRNs for most of the ships. Out of 210 records, 207 had valid LRNs. The remaining 3 records were not matched with LMIS data. Each record represents a total call on the Port of Coos Bay. A call is one entrance and one clearance from Coos Bay.

Table 13-5 (located at the end of this section) is a summary table of all the vessels recorded by the MEPA in 1996 presented by ship-type, engine type, and DWT range. Ship-types were those given in the LMIS data except that similar categories were grouped together for simplicity. Table 13-2 gives the number of calls recorded by the MEPA per ship-type for calendar year 1996. The miscellaneous vessel listed in Table 13-2 had a LMIS ship-type of "cable layer".

Table 13-2. Calls by ship-type as recorded by the MEPA for Coos Bay, OR

MEPA Ship-Type	Calls [a]	% dry-cargo calls [b]
BULK CARRIER	155	74.2%
GENERAL CARGO	54	25.8%
MISCELLANEOUS	1	NA
Grand Total	**210**	**100.0%**

[a] No information on shifting was available for Coos Bay

[b] Percent dry-cargo calls do not include trips for the miscellaneous ship-type

Table 13-3 presents a summary of trips for the USACE waterway codes that are included in the MEPA of the Columbia River database by ship-type. There is some discrepancy in ship-types between the USACE and the MEPA matches with LMIS. The "miscellaneous" vessels in the MEPA database may correspond with some of the "other" vessels in the USACE database, but more data is needed before emissions can be estimated for the vessels in these categories. The totals in Table 13-3 can be used with the methodology in Section 4 to determine calls by ship-type for each Typical Port within the Coos Bay MEPA Area.

Table 13-3. USACE Trips by ship-type for each USACE port/waterway covered by the MEPA of the Columbia River

Typical Port		Ship-Type [a, b]									Total Trips
Rank	Name	BC	CS	GC	PA	RF	RO	TA	VC	UC	
56	Coos Bay	143	0	60	0	17	147	256	0	110	733

[a] BC = Bulk Carrier, CS = Container Ship, GC = General Cargo, PA = Passenger, RF = Reefer, RO = RORO, TA = Tanker, VC = Vehicle Carrier, UC = Unspecified Dry-cargo,

[b] Trip totals do not include intraport movements (vessel movements within the same USACE port/waterway)

For purposes of determining MEPA calls for the Typical Port by ship-type, we suggest allocating the UC trips in Table 13-3 over the dry-cargo ship-types using the percent of dry-cargo calls presented in Table 13-2. For example, Coos Bay, has 110 UC trips. According to Table 13-2, BC trips are 74.2% of the dry-cargo calls for the entire MEPA Area, and 74.2% of 110 is 82. Thus the total revised BC trips for Coos Bay would be 225 trips. This same process should be followed for all the ship-types within the Typical Port. This method of allocating the undefined ship-type trips is the default method. Any data available from the port or other reliable source that indicates a more refined allocation of UC ship-types trips should be used in place of the above method.

13.2 TIME-IN-MODE CALCULATIONS

No data were available from the MEPA for tanker traffic at Coos Bay although there are tanker trips recorded by the USACE. For purposes of time-in-mode calculations, it is suggested that tankers average 80% of the speed used by bulk carriers and thus would have maneuvering, cruise, and RSZ times 25% higher than those for bulk carriers.

Descriptions of time-in-mode are given in Section 3, Table 3-1 of this report. The following descriptions are specific to calculations for Coos Bay. According to conversations with the Port of Coos Bay, the average time from the pilot's station to the nearest berth is 1 hour and the time to the farthest berth is 2 hours with the typical vessel speed being from 6 to 7 knots. As with most of the other Typical Ports, only one pilot is used and this pilot stays with the vessel until it is docked.

13.2.1 Cruise

Cruise speed is the average continuous speed of the vessel in open water. The pilot is picked up 12 to 15 miles from shore and cruise is estimated for the 25 miles preceding this and 25 miles on the clearance trip.

Cruise = 25 / [Vessel Speed (knots)] * 2 **(13.1)**

13.2.2 Reduced Speed Zone

Reduced speed zone (RSZ) time is the time the vessel is at a speed less than full cruise and greater than the 4 knot average used for maneuvering. This speed is typically 6 to 7 knots in Coos Bay. Times were estimated for round-trip RSZ by the distance of the destination port from the breakwater and ranged from 2.4 hours for the closest berths located before North Bend to 4 hours for those in or very near the City of Coos Bay. One-way times and distances are shown in Table 13.4.

Table 13-4. Distances and average times from the breakwater to specific docks within Coos Bay

Dock	Avg. RSZ Distance (miles)	Avg. One-Way Time (hr)
Central Dock	11	1.8
Coos Bay Docks	13	2.0
Dolphin Terminals	11	1.8
Export Services	10	1.5
Georgia Pacific	13	2.0
Glenbrook Nickel	13	2.0
Ocean Terminals	10	1.5
Oregon Chip Terminal	10	1.6
Roseburg Lumber	8	1.2

13.2.3 Maneuvering

Maneuvering for all Coos Bay ports is estimated to take between 15 and 45 minutes each way. A total of 0.6 hours for each berth was used in the time-im-mode calculations.

13.2.4 Hotelling

Hotelling occurs when the vessel is at anchorage or at a berth and can be calculated directly from the MEPA data as follows:

Hotelling (hr/call) = (ETD - ETA) *24 + (DEPTIME - ARRTIME) (13.2)

Where:

ETA	= Arrival date at the dock
ETD	= Departure date from the last dock
DEPTIME	= Departure time from the last dock
ARRTIME	= Arrival time at the dock

13.2.5 Summary Table

The summary table, Table 13-5 reflects the ship-types, vessel characteristics, and time-in-mode data available for the Port of Coos Bay. There are some ship-type categories for which one or more of the data fields had no available data. This is most commonly seen in "Engine Speed" as this was one of the least complete LMIS data fields and as steam turbines do not have engine speed data. There is a large standard deviation for many of the hotelling totals as a few vessels that stayed in port for repairs, retrofit or some other reason had hotelling times in the hundreds or thousands of hours. If one of these long hotelling times occurs for a ship-type category that only have a few calls, the average hotelling time will appear much higher than may actually be typical. In these cases, we recommend using the average hotelling time for the entire ship-type.

13.3 DATA QUALIFIERS

Time-in-mode for RSZ and maneuvering are estimates based on conversations with Coos Bay pilots. The actual time-in-modes associated with these activities may be quite different than the averages in Table 13-5.

Although this database has no data on tug assist, tug assistance will affect the time-in-mode for a vessel. A vessel coming to anchor will not require tug assistance. A dry-cargo vessel docking at a berth will virtually always require tug assistance and will meet the tug approximately two miles from the destination berth. All vessels are under their own power even when docking with tug assistance. The main propulsion engines may be in neutral during the final stages of docking, but they are not shut down until the vessel is secured at the dock or anchorage.

The USACE conducted a federally-authorized deepening of the channel of the Port of Coos Bay during 1996 that was expected to continue to the first quarter of 1997. This was expected to deepen the channel from 35 feet to 37 feet. Thus an accurate accounting of emissions from 1996 should account for dredging. However, this level of dredging is not thought to be normal for a Typical Port, making the data presented in Table 13-5 more suitable for use as a Typical Port without the dredging data.

Table 13-5: Summary of 1996 Deep-Sea Vessel Data for the Port of Coos Bay, OR

Ship-type	Engine Type	DWT Range	Calls	DWT (tonnes)	Power (HP)	Vessel Speed (knots)	Engine Speed (RPM)	%RPM >130	Date of Build	Cruise (hr/call)	RSZ (hr/call)	Maneuver (hr/call)	Hotel (hr/call)
BULK CARRIER	2	< 25,000	26	22,978	7,007	14	149	96%	1993	3.6	3.6	0.6	64.0
		25,000 - 35,000	39	30,108	9,756	15	127	13%	1983	3.4	3.4	0.6	69.4
		35,000 - 45,000	60	42,436	9,136	14	105	6%	1987	3.5	3.0	0.6	58.9
		> 45,000	28	46,825	10,249	14	106	0%	1990	3.5	3.5	0.6	94.8
		(blank)	2	ND	ND	ND	ND	ND	ND	ND	4.0	0.3	179.7
BULK CARRIER Total			**155**	**36,790**	**9,136**	**14**	**117**	**24%**	**1987**	**3**	**3.3**	**0.6**	**70.4**
GENERAL CARGO	2	< 25,000	10	20,800	11,770	16	ND	ND	1980	3.1	3.6	0.6	65.3
		25,000 - 35,000	18	30,068	8,040	14	95	0%	1984	3.5	3.6	0.6	52.5
		35,000 - 45,000	20	42,857	13,010	15	119	0%	1982	3.2	2.7	0.6	56.5
		> 45,000	5	46,547	12,300	16	93	0%	1994	3.1	4.0	0.6	128.5
	4	< 25,000	1	23,168	7,800	15	ND	ND	1978	3.3	3.0	0.6	67.4
GENERAL CARGO Total			**54**	**34,486**	**10,962**	**15**	**103**	**0%**	**1983**	**3**	**3.3**	**0.6**	**63.7**
MISCELLANEOUS	(blank)	(blank)	1	ND	ND	ND	ND	ND	ND	ND	4.0	0.3	128.7
MISCELLANEOUS Total			**1**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**	**ND**	**4.0**	**0.3**	**128.7**
Grand Total			**210**	**36,189**	**9,612**	**15**	**116**	**21%**	**1986**	**3**	**3.3**	**0.6**	**69.0**

SECTION 14

TUG POPULATIONS AND CHARACTERISTICS

For their relatively small size, tugs contain considerable engine power. This power is used for the towage of ships at sea; to assist in maneuvering vessels in confined spaces, particularly when docking and undocking; and to move non self-propelled vessels such as barges. Tugs generally can be divided into three groups: harbor or short-haul tugs, oceangoing or long-haul tugs, and barge tugs. Harbor tugs are usually fitted with a single screw, but are twin-screwed if needed for work beyond a harbor, developing up to 2,500 horsepower with a tonnage up to about 250. Oceangoing tugs are much larger, generally built up to 15,000 horsepower with up to 2,000 tons displacement. Oceangoing tugs are of especially long endurance and are typically used for ocean salvage of ships disabled at sea that require towing to a dockyard for repair, or for the towage of ships, floating docks, etc., to long-distance destinations. Tugs used for barges are generally used within the confines of the port or on the inland river system. Barge tugs are discussed briefly here and in more detail in Volume II, Commercial Marine Activity on the Great Lakes and Inland Rivers of the United States.

Tugs are considered workhorses of the waterways, pushing and pulling barges and guiding passenger ships into safe harbor. These vessels have power platforms specially designed for their work, and the front of the tug rides high to create more surface to help push boats. Currents and wind conditions are critical factors in determining how much power is required to maneuver a vessel into the docking area. A feature of the design of all tugs is the very pronounced overhang of the counter (the arch forming the overhanging stern of a vessel above the waterline). Tugs are always built with a pronounced counter, mainly to keep their towing ropes, when they fall into the water, clear of their huge propellers.

Whenever a tug or other vessel is at a docking area or port facility for an extended period of time, such as for repairs or maintenance, the main propulsion engines are shut down, but one or more auxiliary engines continue to run 24 hours a day for electrical needs.

One example which illustrates a typical harbor tug maneuvering operation is the docking of a large passenger liner, the Queen Elizabeth 2 (QE2), at the Port of New York. Towing companies have tugs on the water 24 hours a day, so as to be able to respond immediately to calls for maneuvering or berthing assistance. In this instance, the Moran Towing and Transportation Company, based in New York, handles the towing services for the QE2. Towing such a large vessel typically requires several tugs. There is always a lead tug, and the Miriam leads this particular operation. Miriam and two of her sister tugs assist the 966-foot long QE2, which weighs 67,000 tons, in arriving at and departing from her berth in the New York harbor. The Miriam is comparatively small, and weighs merely 150 tons, but is equipped with two GM twin-screw, clutch-drive diesel tug engines with a total horsepower of 3,300. The tug is equipped with fuel tanks that have a total capacity of 57,000 gallons, and consumes fuel at the rate of 97 gallons per hour. The Miriam's engines run continuously and the captain and his crew remain on board for a full week at a time. In less than two minutes, the Miriam and the two assist tugs are able to push the QE2 away from the pier in preparation for the outbound voyage. In addition to berthing and harbor maneuvering activities, tugs are an integral component of river traffic, as well as on the Great Lakes, as activity in both areas primarily consists of barges. For example, in the Port of St. Louis on the Mississippi River, the typical traffic is in coal, grain and petroleum. The primary vessel types for such cargo are barges and tugs. Tugs are also referred to interchangeably as towboats and pushboats when used in conjunction with barges. (Towboats and pushboats both "push" barges from behind, and are thus used to refer to the same type of vessel.)

One towboat can tow up to 40 barges, but this number can vary on rivers, as it depends on the river water level. Low water depth affects the river width (thus affecting the number of barges per tow). The depth of the water also affects the amount of cargo that can be carried per barge (the draft is typically 9 feet - if it is less than that, the Army Corps of Engineers puts out a notice to operators on the river). An average load during standard water depth is 1500 tons. For towboats to carry a number of barges at once, they must engage in "fleeting." Fleeting is the activity of gathering barges, and building and breaking tows. There are fleeting areas in river ports specifically for this activity. Another similar type of activity is conducted by a barge carrier. A barge carrier is a "mother ship" that carries smaller container barges called "lash barges." Barge carriers are typically foreign vessels.

Barge movements in deep-sea port and Great Lakes are different from barge movements in river ports. Generally barges used on the Great Lakes are much larger than river barges. Great Lakes barges can exceed 600 feet long and carry over 22,000 tons of cargo. Most large barges are notched so that bow of the tug can push and direct the barge. Many barges of this size also have bow thrusters to assist the barge when maneuvering. For barges of this size, one barge is pushed by one tug.

Table 14-1. LOWER MISSISSIPPI (NEW ORLEANS) AREA FLOATING EQUIPMENT						
		Dimensions Overall				
Operator	Vessel Name	Length (ft)	Width (ft)	Draft Under Load (ft)	Horsepower	Remarks
Diesel Tugs and Towboats						
Bisso, E. N. & Sons, Inc. P.O. Box 4370 New Orleans, LA 70178	Beverly B.	110.0	26.0	13.5	2,300	All tugs engaged in docking and undocking vessels in Lower Mississippi River area
	Captain Bud	81.0	24.0	10.0	1,400	
	Edwin N. Bisso	109.0	33.0	16.0	3,400	
	Gladys B.	110.0	28.0	14.5	3,000	
	J. A. Bisso II	125.0	29.0	14.0	4,200	
	Jackie B.	94.0	25.0	12.5	2,300	
	Miss Sarah	110.0	28.0	14.5	3,000	
	Peggy H.	94.0	25.0	12.5	2,400	
	Sam LeBlanc	94.0	24.0	13.0	2,400	
	Susan W.	97.0	27.0	11.0	2,340	
	Elizabeth B.	104.0	24.0	12.9	3,000	
	A. T. Higgins	105.0	32.0	14.0	3,400	
	C. D. White	100.0	27.0	14.0	2,400	
Bisso Marine, Inc. P.O. box 4113 New Orleans, LA 70178	Rip Tide	120.0	32.0	8.0	1,000	
	Beau Bisso	80.0	23.0	8.5	1,000	
	Tyler	60.0	22.0	6.5	800	
	Darlene Bisso	110.0	27.0	14.0	2,000	
Bisso Towboat Co., Inc. P.O. Box 4250 New Orleans, LA 70178	Capt. Jos. Bisso	105.0	28.0	12.0	4,200	
	Capt. Billy Slatten	125.0	25.0	10.4	3,600	
	Bill S.	105.0	29.0	13.6	3,600	
	Cecilia B. Slatten	105.0	28.0	12.6	3,000	
	Baron	94.0	28.0	13.0	3,000	
	Independent	104.0	27.0	9.5	2,800	
	W. A. Bisso	95.1	28.2	12.1	2,800	
	Mary S.	101.1	26.0	13.6	2,800	
	Triumph	110.0	28.6	15.0	2,600	
	Scott S.	96.0	25.0	11.6	2,400	
	Sandra Kay	95.0	28.0	12.5	2,400	
	Leo	85.0	26.0	10.6	2,200	
	Courtney S.	112.0	28.6	12.0	2,200	
	Alma S.	93.8	24.0	10.6	2,200	
	Elizabeth S.	85.5	23.2	9.5	1,800	

Table 14-1. LOWER MISSISSIPPI (NEW ORLEANS) AREA FLOATING EQUIPMENT

Operator	Vessel Name	Dimensions Overall		Draft Under Load (ft)	Horsepower	Remarks
		Length (ft)	Width (ft)			
Crescent Towing & Salvage Co., Inc. P.O. Box 2699 New Orleans, LA 70176	Glenn Smith	105.0	26.0	12.0	1,850	
	Kevin Smith	105.0	26.0	12.0	1,850	
	Port Hudson	96.0	25.0	13.6	2,400	
	Betty Smith	85.0	29.0	11.0	1,800	Based at Baton Rouge
	Rebecca Smith	105.0	26.0	12.0	1,850	
	Sandra Smith	103.8	25.0	11.6	2,400	
	Craig Smith	87.6	25.0	11.6	1,200	Based at New Orleans
	James E. Smith	98.4	26.2	13.6	1,850	
	Jason Smith	95.0	35.0	12.0	2,250	
	Kyle Smith	105.0	26.0	12.0	1,850	
	Sparta	107.0	25.0	12.6	2,000	
	Terence J. Smith	115.1	25.9	12.2	4,000	
River Parishes Co., Inc. P.O. Box W Lutcher, LA 70071	Ascension	80.0	24.0	11.5	2,000	
	Iberville	90.0	23.0	11.0	2,000	
	St. Charles	85.0	24.0	10.0	1,800	
	St. John	84.0	26.0	9.2	2,150	

Table 14-2. HUDSON RIVER (NEW YORK-NEW JERSEY) AREA FLOATING EQUIPMENT

Operator	Vessel Name	Dimensions Overall		Draft Under Load (ft)	Horsepower	Cargo Capacity (bbls)	Remarks
		Length (ft)	Width (ft)				
Tugs							
McAllister Brothers, Inc. 17 Battery Place New York, NY 10004	Brian A. McAllister	101.0	28.3	12.2	1,800		Towing, docking, undocking, and shifting vessels in New York Harbor, adjacent waters, and coastwise
	Grace McAllister	115.0	30.6	16.8	3,160		
	Isabel A. McAllister	105.0	30.0	15.0	2,400		
	J. P. McAllister	105.0	30.0	15.2	3,160		
	Jane McAllister	110.1	30.0	16.8	3,160		
	Marjorie B. McAllister	111.5	30.0	17.0	3,900		
	McAllister Brothers	100.0	26.6	13.7	1,800		
	Timothy McAllister	102.6	26.7	13.3	2,000		

Table 14-2. HUDSON RIVER (NEW YORK-NEW JERSEY) AREA FLOATING EQUIPMENT							
		Dimensions Overall		Draft Under Load (ft)			
Operator	Vessel Name	Length (ft)	Width (ft)		Horsepower	Cargo Capacity (bbls)	Remarks
Moran Towing and Transportation Co., Inc. Suite 5335 One World Trade Center New York, NY 10048	Amy Moran	107.0	31.0	14.3	3,300		Towing, docking, undocking, and shifting vessels in New York Harbor, adjacent waters, and coastwise
	Carol Moran	106.0	28.6	13.8	1,750		
	Claire Moran	113.0	25.0	13.6	1,750		
	Cynthia Moran	106.0	27.0	14.0	1,750		
	Diana L. Moran	106.0	27.0	14.0	1,750		
	Doris Moran	126.0	31.0	15.6	4,700		
	Dorothy Moran	105.0	31.0	14.0	2,100		
	Elizabeth Moran	110.0	28.5	16.5	4,290		
	Ester Moran	120.0	31.0	17.0	6,500		
	Eugene F. Moran	106.0	27.1	13.9	1,750		
	Judy Moran	107.0	31.0	14.3	3,300		
	M. Moran	120.0	31.6	17.0	6,300		
	Margaret Moran	105.0	31.0	14.0	2,100		
	Marion Moran	126.0	31.0	15.6	4,700		
	Maureen Moran	105.0	29.1	13.6	2,400		
	Miriam Moran	105.0	31.0	14.0	2,100		
	Moira Moran	99.8	29.0	13.6	2,400		
	Nancy Moran	100.5	25.8	13.6	1,800		
	Sheila Moran	126.0	34.0	15.6	4,730		
Turecamo Coastal Towing Corp. 1 Edgewater Plaza Staten Island, NY 10305	Bart J. Turecamo	96.6	28.1	13.0	2,889		Towing, docking, undocking, and shifting vessels in New York Harbor, adjacent waters, and coastwise
	Elizabeth Turecamo	117.0	34.0	16.5	4,300		
	Frances Turecamo	84.8	24.0	9.8	1,600		
	James Turecamo	100.7	27.0	13.0	1,700		
	Jean Turecamo	95.0	27.0	12.8	1,530		
	Jennifer Turecamo	115.0	32.2	16.0	4,300		
	Joan Turecamo	115.0	32.2	16.0	4,300		
	Kathleen Turecamo	91.2	27.2	12.1	2,000		
	Margaret Turecamo	89.4	26.6	11.0	1,800		
	Mary Turacamo	96.6	28.1	15.0	2,900		
	Michael Turecamo	105.0	28.1	13.5	3,200		
	Texaco Capella	105.0	28.1	15.0	3,200		
	Turecamo Girls	91.2	27.2	12.1	2,000		
Bunkering Barges*							
Eklof Marine Corp. 1571 Richmond Terrace Staten island, NY 10310	M/V Chem Trader	145.0	26.0	10.0	400	5,025	2,000 bbl/hr
	M/V Great Lakes	330.0	50.0	17.0	3,600	38,916	4 diesel pumps; 6 hours
	M/V Hudson	253.0	40.0	13.0	1,000	16,734	3,000 bbl/hr
	M/V Jet Trader	156.0	30.0	13.0	400	6,142	2,000 bbl/hr
	M/V John J. Tabeling	181.0	30.0	13.0	400	8,328	2,500 bbl/hr
	M/V Mary A. Whalen	166.0	32.0	12.0	400	8,019	—
	M/V Motor Barge 31	134.0	24.0	12.0	400	4,053	1,500 bbl/hr
	M/V Reliable II	213.7	37.1	13.6	800	16,000	2,000 bbl/hr

*Bunkering barges with horsepower indicated are self-propelled.

Table 14-3. DELAWARE RIVER (PHILADELPHIA) AREA FLOATING EQUIPMENT						
		Dimensions Overall				
Operator	Vessel Name	Length (ft)	Width (ft)	Draft Under Load (ft)	Horsepower	Remarks
Diesel Tugs and Towboats						
Hays Tug and Launch Service Inc. Foot of Highland Avenue Chester, PA 19013	Big Boy	101.0	28.0	14.0	1,200	Towing in Delaware River and vicinity; towing company-owned barges
	Big Daddy	100.0	25.7	11.6	1,200	
	Big Shot	98.0	22.0	8.5	1,200	
	Duchess	46.0	14.0	8.0	235	
	Duke	46.0	14.7	6.0	220	
	Grape Ape	101.0	28.1	7.6	1,800	
	High Roller	100.0	28.0	13.5	2,250	
	Purple Hays	115.0	32.0	8.0	3,600	
	Scooby Doo	104.2	26.1	12.8	1,800	
Maritrans Inc. Fort Mifflin Road Philadelphia, PA 19153	Ambassador	118.4	34.0	18.5	3,800	Towing in Delaware River and vicinity; towing company-owned barges
	Challenger	111.0	32.0	14.5	3,200	
	Columbia	136.5	37.1	17.4	6,140	
	Constitution	153.9	46.7	28.9	11,120	
	Corsair	114.0	34.0	13.8	4,300	
	Cougar	105.0	29.0	15.0	2,200	
	Crusader	111.0	30.2	15.0	3,200	
	Delaware	82.0	26.0	12.5	1,800	
	Diplomat	118.5	34.0	16.8	3,632	
	Endeavor	110.5	32.0	13.0	2,400	
	Independence	136.6	37.1	17.0	5,600	
	Interstate Transporter	90.0	28.0	8.5	1,600	
	Patriot	118.5	34.0	14.6	3,000	
	Ranger	100.6	27.0	13.0	1,700	
	Roanoke	103.0	35.0	8.5	2,100	
	Schuylkill	78.0	28.0	10.5	1,800	
	Traveller	110.0	27.0	13.5	2,200	
	Venturer	111.0	32.0	16.0	3,200	
	Voyager II	111.0	32.0	15.0	3,280	
Moran Towing of Pennsylvania, Inc. 2799 Delaware Avenue Philadelphia, PA 19148	Carolyn	95.0	24.0	13.0	1,800	Towing, docking, undocking, and shifting vessels in Delaware Bay and vicinity
	Grace Moran	107.4	28.0	17.2	3,165	
	Hawkins Point	104.0	27.4	14.0	1,750	
	Reedy Point	97.8	26.0	14.0	2,400	
	Wagners Point	103.0	27.1	13.3	1,750	
R. J. Casho Marine Towing Co. 1 Stoddard Drive Newark, DE 19702	Faith	70.3	22.0	8.0	1,200	Towing, docking, undocking, and shifting vessels in Delaware River and vicinity
	Kathleen Mary 438	67.0	19.0	8.0	600	

Table 14-4. PUGET SOUND (SEATTLE) AREA FLOATING EQUIPMENT						
		Dimensions Overall				
Operator	Vessel Name	Length (ft)	Width (ft)	Draft Under Load (ft)	Horsepower	Remarks
Diesel Tugs and Towboats						
Foss Maritime Co. 353 Alaskan Way South Seattle, WA 98124	John Brix	136.1	35.0	15.0	4,350	Towing, docking, undocking, and shifting vessels in Seattle Harbor and Puget Sound area
	Fairwind	104.5	32.1	12.5	4,200	
	Enterprise	106.5	32.1	12.5	3,000	
	Alapul	104.2	31.1	13.5	3,000	
	Astoria	95.0	27.9	11.5	2,250	
	Janet R	77.5	25.4	8.8	2,200	
	Portland	109.7	26.7	11.8	2,150	
Crowley Marine Services Division of Crowley Maritime 1102 S.W. Massachusetts St. Seattle, WA 98111	Adventurer	127.2	36.5	10.8	9,000	Towing, docking, undocking, and shifting vessels in Seattle Harbor and Puget Sound area
	Bulwark	127.2	36.5	10.8	9,000	
	Cavalier	127.2	36.5	10.8	9,000	
	Commander	127.2	36.5	10.8	9,000	
	Crusader	127.2	36.5	10.8	9,000	
	Gladiator	127.2	36.5	10.8	9,000	
	Guardsman	127.2	36.5	10.8	9,000	
	Hunter	127.2	36.5	10.8	9,000	
	Invader	127.2	36.5	10.8	9,000	
	Navigator	127.2	36.5	10.8	9,000	
	Ranger	127.2	36.5	10.8	9,000	
	Sentry	127.2	36.5	10.8	9,000	
	Stalwart	127.2	36.5	10.8	9,000	
	Warrior	127.2	36.5	10.8	9,000	
	Guardian	127.2	36.5	10.8	7,000	
	Mars	127.2	36.5	10.8	7,000	
	Path Finder	127.2	36.5	10.8	7,000	
	Sea Flyer	127.2	36.5	10.8	7,000	
	Sea Swift	127.2	36.5	10.8	7,000	
	Mercury	105.8	29.8	12.0	5,250	
	Geronimo	121.1	32.0	10.9	4,800	
	Sea Racer	115.2	31.1	10.4	3,500	
	Vigilant	115.2	31.1	10.4	3,500	
	Howard H.	117.0	32.0	10.7	3,200	
	Blackhawk	112.1	34.0	11.2	3,000	
	Seneca	106.3	34.3	10.0	2,900	
	Sioux	106.3	34.0	10.0	2,900	
	Sea Lion	115.2	31.1	10.4	2,800	
	Sea Wolf	115.2	31.1	10.4	2,800	
	Arthur S.	94.6	30.0	9.7	2,440	
	Sea Giant	116.4	28.2	15.6	2,400	
	Daring	115.2	31.1	10.4	2,200	
	Apollo	81.4	28.0	9.2	2,000	
	Avenger	98.5	23.6	8.9	2,000	
	Hercules	81.4	28.0	9.2	2,000	
	Juniper	81.4	28.0	9.2	2,000	

Table 14-4. PUGET SOUND (SEATTLE) AREA FLOATING EQUIPMENT						
		Dimensions Overall				
Operator	Vessel Name	Length (ft)	Width (ft)	Draft Under Load (ft)	Horsepower	Remarks
	San Diegan	100.1	26.7	9.6	2,000	
	George S.	94.2	25.1	11.3	1,650	
Crowley Marine Services (Cont.)	Sea Rover	92.9	24.7	11.8	1,550	Towing, docking, undocking, and shifting vessels in Seattle Harbor and Puget Sound area
Division of Crowley Maritime	Puerto Nuevo	89.4	28.1	9.5	1,530	
1102 S.W. Massachusetts St.	Sea Breeze	117.2	28.0	12.8	1,500	
Seattle, WA 98111	Neptune	94.0	26.6	10.7	1,380	
	Theiline W.	96.3	25.2	10.8	1,185	
	Colville River	64.0	27.0	5.7	1,095	
	Sag River	64.0	27.0	5.7	1,095	
	Toolik River	64.0	27.0	5.7	1,095	
	Vigorous	95.6	24.1	10.8	1,020	
	Titan	61.8	17.1	7.0	800	
	Trojan	61.3	17.1	6.1	800	
	Agloo	69.3	21.2	8.8	770	
	Kavik	77.3	21.2	8.8	680	
	Noatak	76.4	21.2	8.8	680	
	Koyuk	74.8	24.0	5.2	480	
	Champion II	61.6	17.1	6.1	475	
	Jeff W.	43.8	14.5	6.4	365	
	Mop King	46.1	22.0	4.7	350	
	Prudhoe Bay	46.1	22.0	4.7	350	
	Kobuk	60.5	22.1	4.7	330	
Island Tug & Barge Co.	Gail S.	82.1	26.0	12.0	1,800	Towing, docking, undocking, and shifting vessels in Seattle Harbor and Puget Sound area
14789 Sunrise Drive N.E.	Paula S.	95.0	25.2	11.9	1,300	
Bainbridge Island, WA 98110	Patricia S.	65.0	18.0	10.0	850	
	Helen S.	61.3	17.1	9.5	750	
	Wanda S.	55.9	20.1	7.6	600	
Foss Maritime Co.	Barbara Foss	120.2	34.0	16.0	4,300	Towing, docking, undocking, and shifting vessels in Seattle Harbor and Puget Sound area
660 W. Ewing Street	Justine Foss	118.7	34.0	16.0	4,300	
Seattle, WA 98119	Wendy Foss	117.6	34.0	16.2	4,050	
	Andrew Foss	101.8	38.2	14.2	4,000	
	Arthur Foss	101.8	38.2	14.2	4,000	
	Sandra Foss	106.2	34.0	15.8	3,915	
	Stacey Foss	106.2	34.0	15.8	3,915	
	Brynn Foss	96.3	36.0	13.5	3,000	
	Drew Foss	120.2	34.0	16.0	3,000	
	Henry Foss	96.3	36.0	13.6	3,000	
	Jeffrey Foss	114.4	31.0	14.9	3,000	
	Phillips Foss	114.4	31.0	14.9	3,000	
	Richard Foss	104.8	30.0	13.8	3,000	
	Shelley Foss	84.4	30.0	14.2	3,000	
	Sidney Foss	120.2	34.0	16.0	3,000	
	Wedell Foss	96.0	36.0	13.6	3,000	
	Iver Foss	94.7	32.0	14.9	2,400	

Table 14-4. PUGET SOUND (SEATTLE) AREA FLOATING EQUIPMENT						
Operator	Vessel Name	Dimensions Overall Length (ft)	Dimensions Overall Width (ft)	Draft Under Load (ft)	Horsepower	Remarks
Foss Maritime Co. (Cont.) 660 W. Ewing Street Seattle, WA 98119	Benjamin Foss	76.0	26.5	11.5	2,379	Towing, docking, undocking, and shifting vessels in Seattle Harbor and Puget Sound area
	David Foss	76.0	26.5	11.4	2,379	
	Edith Foss	76.0	26.5	11.4	2,379	
	Daniel Foss	94.7	32.0	14.9	2,250	
	Carol Foss	84.8	24.3	12.8	1,875	
	Shannon Foss	84.8	24.3	12.8	1,875	
	Catherine Foss	73.5	25.0	9.0	1,830	
	Claudia Foss	73.5	25.0	8.6	1,830	
	Martha Foss	74.1	26.6	8.4	1,620	
	Donna Foss	66.7	24.0	10.2	1,450	
	Duncan Foss	66.7	24.0	10.2	1,450	
	Deborah Foss	66.7	24.0	10.2	1,300	
	Diane Foss	66.7	24.0	10.2	1,300	
	Dorothy Foss	66.7	24.0	10.2	1,300	
	Dean Foss	66.7	24.0	10.2	1,200	
Foss Maritime Co. 225 East F Street Tacoma, WA 98421	FRV 5	32.0	8.0	2.0	310	Docking, undocking, shifting, and towing vessels in Puget Sound and its tributaries
	Omer Foss	45.0	14.3	6.0	360	
	Kelly Foss	47.0	16.5	8.0	565	
	Duncan Foss	72.0	24.0	8.0	1,450	
	Brynn Foss	100.0	36.0	16.2	3,000	
	Henry Foss	100.0	36.0	16.2	3,000	
Dunlap Towing Co. 1500 W. Ediz Hook Road Port Angeles, WA 98362	Pull-and-Be-Dammed	28.3	12.0	3.7	240	
	Samish	71.0	17.2	8.0	565	
Dunlap Towing Co. 2702 Federal Avenue Everett, WA 98201	Gene Dunlap	123.0	30.0	11.0	3,000	Ocean tugs based in Everett
	Malolo	105.0	31.0	13.5	2,320	
	Manfred Nystrom	127.5	32.0	10.3	4,200	
	Mike O'Leary	109.0	31.0	16.0	2,250	
	Snohomish	110.0	31.2	14.0	2,250	
	Suiattle	120.0	29.5	17.4	3,070	
	Taurus	89.5	27.0	14.0	2,400	
	Camano	34.0	11.3	4.6	190	Harbor tugs based in Everett
	Cedar King	47.0	14.0	7.0	365	
	Port Gardner	38.5	11.3	4.0	308	
	Port Susan	42.0	16.0	5.5	365	
	Puyallup	49.1	11.4	4.7	330	
	Quilceda	52.0	16.5	6.0	700	
	Sneeoosh	38.0	13.6	6.0	365	
	Uffda	30.0	9.5	4.0	90	
	Whidbey	43.0	12.5	9.5	202	
	Yokeko	30.0	10.6	5.0	135	

Table 14-4. PUGET SOUND (SEATTLE) AREA FLOATING EQUIPMENT						
		Dimensions Overall				
Operator	Vessel Name	Length (ft)	Width (ft)	Draft Under Load (ft)	Horsepower	Remarks
	Lummi	65.0	17.0	5.0	725	Puget Sound vessels based in LaConner
	Skagit Chief	100.0	25.1	11.0	1,125	
	Swinomish	74.0	20.0	10.0	850	
	Vulcan	73.0	18.0	7.1	525	

Table 14-4. PUGET SOUND (SEATTLE) AREA FLOATING EQUIPMENT						
		Dimensions Overall				
Operator	Vessel Name	Length (ft)	Width (ft)	Draft Under Load (ft)	Horsepower	Remarks
Foss Maritime Co. 937 Boat Haven Drive Port Angeles, WA 98363	Joe Foss Richard M.	45.0 92.0	15.0 28.6	6.9 13.0	365 2,200	
Bunkering Vessels						
Rainier Petroleum Corp. 1711 13th Avenue S.W. Seattle, WA 98134	Dagwood Sterling	42.0 42.0	15.0 16.0	5.5 6.0	200 200	Providing lubricating oil to vessels at berth in Seattle Harbor and Puget Sound area

Table 14-5. CORPUS CHRISTI AREA FLOATING EQUIPMENT						
		Dimensions Overall				
Operator	Vessel Name	Length (ft)	Width (ft)	Draft Under Load (ft)	Horsepower	Remarks
Diesel Tugs and Towboats						
G. & H. Towing Co. P.O. Box 9488 Corpus Christi, TX 78408	Manta Philip K. (1) Denia (2) Marlin Mars (3)	118.0 96.0 95.0 103.0 90.0	31.0 32.1 32.0 25.2 27.0	16.6 12.6 16.0 10.8 13.2	4,000 4,000 3,000 1,950 1,700	Towing, docking, undocking, and shifting vessels in Corpus Christi Harbor and vicinity
Coastal Tank & Barg, Inc. A subsidiary of the Coastal Corp. 504 Navigation Blvd. Corpus Christi, TX 78403	Coastal No. 31 Coastal No. 22	264.0 250.0	50.2 45.0	9.5 11.0	20,000 bbls cargo capacity 20,000 bbls cargo capacity	Towed by 800-hp tug "Coastal Nueces"

(1) Owned by Bay-Houston Towing Co.
(2) Owned by Suderman & Young Towing Co., Inc.
(3) Owned by Intracoastal Towing & Transportation Corp.

Table 14-6. TAMPA BAY AREA FLOATING EQUIPMENT						
Operator	Vessel Name	Dimensions Overall Length (ft)	Dimensions Overall Width (ft)	Draft Under Load (ft)	Horsepower	Remarks
Diesel Tugs and Towboats						
Bay Transportation Corp. d.b.a. St. Philip Towing 1305 Shoreline Drive P.O. Box 5797 Tampa, FL 33675	A. P. St. Philip Bradenton Gloria Kinsman Challenger Palmetto Tampa	95.0 105.0 103.0 110.0 105.0 100.0	26.0 26.0 26.0 31.0 26.0 30.0	13.0 13.0 13.0 13.0 13.0 14.0	3,300 3,300 3,300 3,600 3,300 6,000	Towing, docking, undocking, and shifting vessels in Tampa Bay
Bay Transportation Corp. d.b.a. Manatee Tug and Barge 1305 Shoreline Drive P.O. Box 5797 Tampa, FL 33675	Edna St. Philip Yvonne St. Philip	97.0 103.0	30.0 26.0	12.0 13.0	3,300 3,300	Towing, docking, undocking, and shifting vessels in Tampa Bay
Bay Transportation Corp. d.b.a. Leonardi Towing 1305 Shoreline Drive P.O. Box 5797 Tampa, FL 33675	Avon Dorothy Orange	68.0 30.0 93.0	15.6 12.0 24.0	11.0 5.0 14.0	1,200 325 2,000	Towing, docking, undocking, and shifting vessels in Tampa Bay
Bay Transportation Corp. d.b.a. Bay Towing 1305 Shoreline Drive P.O. Box 5797 Tampa, FL 33675	Harbor Island Tampa Bay Trooper	65.0 60.0 62.6	21.0 22.0 20.0	9.0 9.0 9.0	1,000 1,000 1,000	Towing, docking, undocking, and shifting vessels in Tampa Bay

Table 14-7. BALTIMORE AREA FLOATING EQUIPMENT						
		Dimensions Overall				
Operator	Vessel Name	Length (ft)	Width (ft)	Draft Under Load (ft)	Horsepower	Remarks
Diesel Tugs and Towboats						
Moran Towing of Maryland, Inc. The World Trade Center Suite 800 Baltimore, MD 21202	Cape Romain Cape Henlopen Fells Point Kings Point Grace Moran Georgia Moran	107.6 107.2 105.0 105.0 101.0 99.0	34.8 31.0 27.0 27.0 28.0 27.0	13.7 15.6 14.0 14.0 14.0 14.0	3,800 3,800 2,400 2,400 3,165 1,750	Towing, docking, undocking, and shifting vessels in Baltimore Harbor
Sadowski Towing Co., Inc. 905 S. Wafe Baltimore, MD 21222	E. Homan Stroud Helen S. Victory	70.0 71.2 65.0	21.0 19.0 17.0	10.2 8.8 6.0	500 700 350	Towing, docking, undocking, and shifting vessels in Baltimore Harbor

Note: Additional floating equipment in use in Baltimore Harbor for specialized uses, such as lightering, is not included.

Table 14-8. COOS BAY AREA FLOATING EQUIPMENT						
		Dimensions Overall				
Operator	Vessel Name	Length (ft)	Width (ft)	Draft Under Load (ft)	Horsepower	Remarks
Diesel Tugs and Towboats						
Coos Bay Towboat Co. P.O. Box 777 Coos Bay, OR 97420	Cape Arago Coos Bay North Bend	61.3 71.0 66.4	17.1 23.3 21.5	9.0 9.2 9.8	1,000 1,425 1,800	Towing, docking, undocking, shifting, and transferring pilots to and from vessels in Port of Coos Bay
Knutson Towboat Co. 400 N. Front Street Coos Bay, OR 97420	Captain Louie Koos 2 Koos 4 Koos 6 Koos 7 Koos 8 Koos King Ranger Thea Knutson The Goose Widgeon William Vaughan	56.0 49.7 40.0 26.0 36.1 32.0 65.0 45.6 38.5 36.5 35.0 43.0	22.0 12.8 13.8 11.0 12.3 11.0 23.5 13.6 13.0 12.0 13.6 11.8	6.6 3.8 4.4 3.6 4.6 4.0 8.0 5.9 6.0 3.8 3.9 5.0	1,750 450 320 115 290 175 1,800 550 400 330 175 320	Towing, docking, undocking, and shifting vessels in Port of Coos Bay and along Oregon coast

Table 14-8. COOS BAY AREA FLOATING EQUIPMENT						
		Dimensions Overall				
Operator	**Vessel Name**	**Length (ft)**	**Width (ft)**	**Draft Under Load (ft)**	**Horsepower**	**Remarks**
Sause Bros. Ocean Towing Co. 151 East Market Street Coos Bay, OR 97420	Muleduzer	47.1	15.0	5.0	650	
Port of Newport 600 S.E. Bay Boulevard P.O. Box 1065 Newport, OR 97365	Little Pull* Unnamed Yaquina Bay	26.0 33.0 65.0	7.0 8.0 18.0	4.0 4.0 6.5	135 225 375	Towing, docking, undocking, shifting, and transferring pilots to and from vessels in Port of Newport

*Gasoline powered.

SECTION 15

FERRY POPULATION AND CHARACTERISTICS

Ferry activity in the Ports of Puget Sound/Seattle, New York, and Philadelphia is primarily commuter traffic, with charter, tour, special event and private cruises making up a small proportion of trips. Ferry traffic in the other MEPA Areas is negligible or non-existent. Most of the ferries on the water spend minimum time at the dock, ranging from a minimum of 2 to 3 minutes to a normal maximum of 20 minutes between trips. This typically amounts to 95 to 97% of each operating day at cruise, 2 to 4% hotelling, and a negligible amount maneuvering and at reduced speeds. Ferries vary significantly in size, passenger capacity, horsepower, and cruising speed, ranging from water taxis with 240 hp and a 10 knot cruising speed, to large 7000 passenger ferries running with 7,000 hp at 18 knots. There are also mid-sized high-speed monohulls or catamarans which can run up to 28 to 35 knots with 3,500 to 5,400 hp.

There is significant variation in ferry operator size as well. Puget Sound, for example, has the largest single-operator ferry fleet in the United States. The operator, Washington State Ferries (WSF), runs 27 ferries on ten routes, and carries over 25 million passengers annually. In contrast, small water taxi services, such as Prospect Fast Ferry in New York Harbor, operate only one ferry, serving one route with 4 trips per day.

The following sections illustrate the ferry activity in the three MEPA Areas with extensive ferry service. These Areas of Puget Sound (Seattle), Hudson River (New York), and Delaware River (Philadelphia) were determined to have ferry traffic significant enough for inclusion in this study. For each of the MEPA Areas, the primary ferry operators, both public and privately run, were researched. Some ferry operators were able to provide more complete information on their fleet activity than others. Where available, information gathered and calculated include: applicable ferry route(s), time in minutes of an average one-way trip, the number of weekday as well as weekend and holiday trips, average running time (in hours per year), the number of ferries in the fleet, average ferry cruising speed in knots, horsepower, and percentage of time spent cruising vs. idling. Any other pertinent information is included where possible. In cases where trip numbers and length are unavailable, average running time is calculated from daily running hours based on ferry operating records.

15.1 PUGET SOUND FERRIES

Washington State Ferries (WSF) is the primary ferry operator in the Seattle/Puget Sound area. WSF is a public agency, and was founded in 1951 with the State's purchase of Puget Sound Navigation Company. There are 27 vessels in the fleet. In 1997, WSF carried a total of 25,586,614 passengers on ten routes, serving 20 terminals. The in-use ferry fleet averages 586 one-way trips per day, which totals approximately 2,500 miles each day. The average amount of fuel used per year by the WSF ferry fleet is estimated at about 17 million gallons of diesel fuel. There is a considerable range in fuel consumption between ferries. Depending on size, engines and horsepower ferries consume anywhere from 15 to 240 gallons of fuel per hour.

Table 15-1 includes information about each route, including ferry name, age (dates built and rebuilt), average cruising speed in knots, horsepower, number and type of engine, draft, and gross/net tonnage. Route details also include the average one-way trip time in minutes, the average number of trips daily, the average running time calculated out to hours per year (including an estimate of 15 minutes idling time at the dock at each trip end), as well as the number of ferries serving route.

Table 15-1. Washington State Ferries

Route: Seattle-Bainbridge Island	
Average one-way trip:	35 minutes
Average round trips daily:	22
Average running time:	9343 hours/year
Average idling time:	4004 hours/year
# ferries serving route:	2
Ferry:	**Wenatchee**
Ferry age (date built):	1998
Average cruising speed:	18
Horsepower:	13,200
Engines:	4 Diesel-Electric (AC)
Draft:	17'3"
Gross/Net tonnage:	N/A
Ferry:	**Tacoma**
Ferry age (date built):	1997
Average cruising speed:	18
Horsepower:	13,200
Engines:	4 Diesel-Electric (AC)
Draft:	17'3"
Gross/Net tonnage:	N/A

Table 15-1. Washington State Ferries (Continued)

Route: Seattle-Bremerton	
Average one-way trip: Average round trips daily: Average running time: Average idling time: # ferries serving route:	60 minutes (auto ferry) 12 8736 hours/year 2184 hours/year 2
Ferry: Ferry age (date built): Average cruising speed: Horsepower: Engines: Draft: Gross/Net tonnage:	**Chelan** 1981 16 5,000 2 Diesel 15'6" 2477/1772
Ferry: Ferry age (date built): Average cruising speed: Horsepower: Engines: Draft: Gross/Net tonnage:	**Kitsap** 1980 (rebuilt 1992) 16 5,000 2 Diesel 16'6" 2475/1755
Route: Seattle-Bremerton	
Average one-way trip: Average round trips daily: Average running time: Average idling time: # ferries serving route:	50 minutes (passenger ferry) 7 4247 hours/year 1274 hours/year 2
Ferry: Ferry age (date built): Average cruising speed: Horsepower: Engines: Draft: Gross/Net tonnage:	**Tyee** 1985 (rebuilt 1993) 25 2,990 2 Diesel 7' 98/66
Ferry: Ferry age (date built): Average cruising speed: Horsepower: Engines: Draft: Gross/Net tonnage:	**Chinook** 1998 30-34 7,200 4 Diesel-Waterjet 5' 99/67

Table 15-1. Washington State Ferries (Continued)

Route: Edmonds-Kingston	
Average one-way trip: Average trips daily: Average running time: Average idling time: # ferries serving route:	30 minutes 25 4550 hours/year 2275 hours/year 2
Ferry: Ferry age (date built): Average cruising speed: Horsepower: Engines: Draft: Gross/Net tonnage:	**Walla Walla** 1972 18 11,500 4 Diesel-Electric (DC) 16' 3246/1198
Ferry:	**Spokane**
Ferry age (date built): Average cruising speed: Horsepower: Engines: Draft: Gross/Net tonnage:	1972 18 11,500 4 Diesel-Electric (DC) 16' 3246/1198
Route: Fauntleroy-Vashon	
Average one-way trip: Average round trips daily: Average running time: Average idling time: # ferries serving route:	15 minutes 32 5824 hours/year 5824 hours/year 3
Ferry: Ferry age (date built): Average cruising speed: Horsepower: Engines: Draft: Gross/Net tonnage:	**Issaquah** 1979 (rebuilt 1989) 16 5,000 2 Diesel 16'6" 2475/1755
Ferry: Ferry age (date built): Average cruising speed: Horsepower: Engines: Draft: Gross/Net tonnage:	**Klahowya** 1958 (rebuilt 1995) 13 2,500 2 Diesel-Electric 13'10" 1334/907

Table 15-1. Washington State Ferries (Continued)

Ferry:	**Tillikum**
Ferry age (date built):	1959 (rebuilt 1994)
Average cruising speed:	13
Horsepower:	2,500
Engines:	2 Diesel-Electric
Draft:	13'10"
Gross/Net tonnage:	2070/1487/907
Route: Fauntleroy-Southworth	
Average one-way trip:	35 minutes
Average round trips daily:	24
Average running time:	10192 hours/year
Average idling time:	4368 hours/year
# ferries serving route:	3
Ferry:	**Issaquah**
Ferry age (date built):	1979 (rebuilt 1989)
Average cruising speed:	16
Horsepower:	5,000
Engines:	2 Diesel
Draft:	16'6"
Gross/Net tonnage:	2475/1755
Ferry:	**Klahowya**
Ferry age (date built):	1958 (rebuilt 1995)
Average cruising speed:	13
Horsepower:	2,500
Engines:	2 Diesel-Electric
Draft:	13'10"
Gross/Net tonnage:	1334/907
Ferry:	**Tillikum**
Ferry age (date built):	1959 (rebuilt 1994)
Average cruising speed:	13
Horsepower:	2,500
Engines:	2 Diesel-Electric
Draft:	13'10"
Gross/Net tonnage:	1487/907
Route: Southworth-Vashon	
Average one-way trip:	10 minutes
Average round trips daily:	22
Average running time:	2669 hours/year
Average idling time:	4004 hours/year
# ferries serving route:	3

Table 15-1. Washington State Ferries (Continued)

Ferry: Ferry age (date built): Average cruising speed: Horsepower: Engines: Draft: Gross/Net tonnage:	**Issaquah** 1979 (rebuilt 1989) 16 5,000 2 Diesel 16'6" 2475/1755
Ferry: Ferry age (date built): Average cruising speed: Horsepower: Engines: Draft: Gross/Net tonnage:	**Klahowya** 1958 (rebuilt 1995) 13 2,500 2 Diesel-Electric 13'10" 1334/907
Ferry: Ferry age (date built): Average cruising speed: Horsepower: Engines: Draft: Gross/Net tonnage:	**Tillikum** 1959 (rebuilt 1994) 13 2,500 2 Diesel-Electric 13'10" 1487/907

Table 15-1. Washington State Ferries (Continued)

Route: Vashon-Seattle (passenger only)	
Average one-way trip: Average round trips daily: Average running time: Average idling time: # ferries serving route:	25 minutes 9 2730 hours/year 1638 hours/year 2
Ferry: Ferry age (date built): Average cruising speed: Horsepower: Engines: Draft: Gross/Net tonnage:	**Skagit** 1989 25 3,840 4 Diesel 8' 96/65
Ferry: Ferry age (date built): Average cruising speed: Horsepower: Engines: Draft: Gross/Net tonnage:	**Kalama** 1989 25 3,840 4 Diesel 8' 96/65
Route: Port Defiance-Tahlequah	
Average one-way trip: Average round trips daily: Average running time: Average idling time: # ferries serving route:	15 minutes 18 3276 hours/year 3276 hours/year 1
Ferry: Ferry age (date built): Average cruising speed: Horsepower: Engines: Draft: Gross/Net tonnage:	**Rhododendron** 1947 (rebuilt 1990) 11 2,172 1 Diesel 10' 937/435
Route: Port Townsend-Keystone	
Average one-way trip: Average trips daily: Average running time: Average idling time: # ferries serving route:	30 minutes 8 (increases with weekend schedule) 1456 hours/year 728 hours/year 2

Table 15-1. Washington State Ferries (Continued)

Ferry: Ferry age (date built): Average cruising speed: Horsepower: Engines: Draft: Gross/Net tonnage:	**Klickitat** 1927 (rebuilt 1981) 12 2,400 2 Diesel-Electric (DC) 12'9" 1369/931
Ferry: Ferry age (date built): Average cruising speed: Horsepower: Engines: Draft: Gross/Net tonnage:	**Illahee** 1927 (rebuilt 1986) 12 2,896 2 Diesel-Electric (DC) 12'9" 1369/931
Route: Mukilteo-Clinton	
Average one-way trip: Average trips daily: Average running time: Average idling time: # ferries serving route:	20 minutes 40 7280 hours/year 3640 hours/year 2
Ferry: Ferry age (date built): Average cruising speed: Horsepower: Engines: Draft: Gross/Net tonnage:	**Kittitas** 1980 (rebuilt 1990) 16 5,000 2 Diesel 16'6" 2477/1772
Ferry: Ferry age (date built): Average cruising speed: Horsepower: Engines: Draft: Gross/Net tonnage:	**Cathlamet** 1981 (rebuilt 1993) 16 5,000 2 Diesel 16'6" 2477/1722

Table 15-1. Washington State Ferries (Continued)

Route: Anacortes-San Juan Island-Sidney, B.C.	
Average one-way trip:	1 hour 55 minutes Anacortes to San Juan Island 1 hour 25 minutes SJI to Sidney, B.C.
Average round trips daily:	12 - Anacortes to San Juan Islands
Average trips daily:	2 in summer, 1 in off-season - Anacortes to Sidney
Average running time:	16744 hours/year - Anacortes to San Juan Islands
Average idling time:	2184 hours/year - Anacortes to San Juan Islands
Average running time:	645 hours/year - Anacortes to Sidney
Average idling time:	114 hours/year - Anacortes to Sidney
Total average running time:	17389 hours/year
Total average idling time:	2298 hours/year
# ferries serving route:	5
Ferry:	**Hyak**
Ferry age (date built):	1967
Average cruising speed:	17
Horsepower:	8,000
Engines:	4 Diesel-Electric (DC)
Draft:	18'6"
Gross/Net tonnage:	2704/1214
Ferry:	**Yakima**
Ferry age (date built):	1967
Average cruising speed:	17
Horsepower:	8,000
Engines:	4 Diesel-Electric (DC)
Draft:	18'6"
Gross/Net tonnage:	2704/1214
Ferry:	**Elwha**
Ferry age (date built):	1967 (rebuilt 1991)
Average cruising speed:	20
Horsepower:	10,200
Engines:	4 Diesel-Electric (DC)
Draft:	18'9"
Gross/Net tonnage:	2813/1322
Ferry:	**Evergreen State**
Ferry age (date built):	1954 (rebuilt 1988)
Average cruising speed:	13
Horsepower:	2,500
Engines:	2 Diesel-Electric (DC)
Draft:	15'3"
Gross/Net tonnage:	2041/1017

Table 15-1. Washington State Ferries (Concluded)

Ferry:	**Nisqually**
Ferry age (date built):	1927 (rebuilt 1987)
Average cruising speed:	12
Horsepower:	2,896
Engines:	2 Diesel-Electric (DC)
Draft:	12'9"
Gross/Net tonnage:	1368/930

The calculations of hourly running time per year for the Washington State Ferries fleet assumed that route schedules are not interrupted by ferry maintenance. This means that another ferry from the fleet would service the route while the regularly scheduled ferry is undergoing maintenance. Each ferry is scheduled for maintenance approximately 4 weeks of the year. The annual running time calculations also use daily schedules, and do not differentiate between weekday and weekend service. Thus average running time was calculated according to Equation 15.1.

$$T_R = t_{oo} * n * 12.1\overline{3} \qquad \textbf{(15.1)}$$

TR = Total running time in hours per year

t_{oo} = Average time for one-way trip in minutes

n = Number of round trips per day

12.13 = Conversion factor of 2 one way trips per round times 7 days per week, times 52 weeks per year, times one hour per 60 minutes.

Several other generalizations may be made about the Washington State Ferry fleet and operations. Full ferry speed is used throughout the fleet on each run, with the exception of departures and landings. The typical power level estimated for each class at cruising speed is approximately 80% of full power. Dock entry is variable dependent on factors such as tides, weather, and loading. Ferry engines continue to run to push the vessel against the dock while in dock. There is no maximum time a ferry will idle before shutting down its engines at the dock, but the typical time is 15-20 minutes. With this generalization, in the above calculations, an average idling time with engines running at the end of each one-way trip was assumed to be 15 minutes. Thus average idling time was calculated according to Equation 15.2.

$$T_I = t_i * n * 12.1\overline{3} \qquad \textbf{(15.2)}$$

TI = Average idling time at each trip end, in hours total per year.

t_i = Average idling time per trip, default value is 15 minutes

n = Number of round trips per day

12.13 = Conversion factor of 2 one way trips per round times 7 days per week, times 52 weeks per year, times one hour per 60 minutes.

15.2 NEW YORK FERRIES

Ferries in the New York Area include both New York City Department of Transportation (NY DOT) service as well as private ferry operators licensed by the NY DOT. These ferries serve primarily commuter routes, and are detailed by operator in the tables below. Information in the tables on each route and vessel includes, if possible: average one-way trip time in minutes, number of weekday as well as weekend and holiday trips, average running time calculated out to hours per year, number of ferries in the operator's fleet, average vessel cruising speed, horsepower, and percent of time idling vs. cruising. Any additional relevant information is also included.

Table 15-2. New York Department of Transportation Staten Island Ferry

NEW YORK CITY DEPARTMENT OF TRANSPORTATION (NY DOT) STATEN ISLAND FERRY 718-390-5253	
Route:	**Staten Island-Lower Manhattan**
Average one-way trip:	25 minute
# weekday trips:	101
# weekend/holiday trips:	64
Average running time:	3300 hours/year
# ferries in fleet:	7
Average cruising speed:	18 knots
hp	2 ferries are 300 ft in length, 7000 passengers, 7000 hp 5 ferries are 260 ft in length, 6050 hp

Table 15-3. New York Fast Ferry

NEW YORK FAST FERRY 718-815-6942	
Route:	**Staten Island-Midtown Manhattan**
Average one-way trip:	20 minutes
# weekday trips:	26
# weekend/holiday trips:	—
Average running time:	520 hours/year (with 5 day weeks)
# ferries in fleet:	2
Average cruising speed:	35 knots
hp	2 ferries, 5400 hp, operate at 85-90% of hp at cruising speed

Table 15-4. Express Navigation Ferry

EXPRESS NAVIGATION Gary Dunzelman -732-872-2628 x601	
Route:	**multiple**
Average running time:	7098 hours/year (6 hours/day, add 2-3 hours in summer season)
# ferries in fleet:	3
Average cruising speed:	24 knots
hp	2 catamarans=28 knots at cruising speed (30 knots is max) 1 monohull=20 knots is cruising speed 2 catamarans, each =3500 hp 1 monohull=1860 hp

The two catamarans are each 82 feet and carry 300 passengers. One monohull vessel carries 149 passengers. Using average running times of 6 and 8 hours/day for the three summer months, the two catamarans with rated horsepowers of 3,500 hp and cruising speed of 28 knots operate a total of 4732 hours and the monohull, with 1,860 hp and a cruising speed of 20 knots, operates 2366 hours.

Table 15-5. New York Waterways

NEW YORK WATERWAYS R. Bostick - 201-902-8841	
Route:	**numerous**
# total trips:	540 trips/day 196,434 trips/year
Average running time:	Average 11 hours/day (7 days/week, year round) 4004 hours/year
# ferries in fleet:	20 (currently running 19-20 each day)
Average cruising speed:	10-12 knots, which is 70% of capacity One catamaran runs 25-26 knots, approx. 12 hours/day
hp	All boats 1200-1500 hp
% time cruising vs. idling	Only 2-3 minutes at dock between trips
Age of ferries:	Oldest is 10 years old (all bought new by company), 5 are less than 3 years old

Ninety-nine percent of the trips run by New York Waterways are commuter trips (7 days/week, year round). Of the 540 total trips per day, about 6 are harbor cruises or "leisure" trips, except between January & March.

As an example of the volume and turn-around time of this particular ferry fleet, during peak commuter hours, boats depart from Hoboken every 5 minutes, and depart from Midway every 10 minutes. In addition, two boats run to La Guardia airport all day, and departures from Weehawken to Wallstreet run every hour.

Table 15-6. Prospect Fast Ferry

PROSPECT FAST FERRY Doreen - 732-872-1450 @ Sandy Harbor Marina	
Route:	**Sandy Hook Bay Marina (Highlands, NJ) to Pier 11 and East 34th Street, Manhattan**
Average one-way trip:	Avg. 55 minutes (from online schedule) a.m. = 55-70 minutes p.m. = 55 minutes
# weekday trips:	4/day
# weekend/holiday trips:	2/day
Average running time:	55*4*5 (weekday) + 55*2*2 (weekend) TOTAL = 953+191 = 1144 hours/year
# ferries in fleet:	1

No further information was available on the vessel operated by the Prospect Fast Ferry.

Table 15-7. Four Lauderdale Water Taxi

FORT LAUDERDALE WATER TAXI Doug Freid - 201-985-1164 (office) or 917-653-4544 (his cell phone)	
Route:	**Liberty State Park (Jersey City, NJ) to World Financial Center and Pier 11 at Wall Street, Manhattan**
Average running time:	weekdays = 8 hrs, 12 hrs, 18 hrs for 3 ferries weekends = 5 hrs, 9 hrs, 15 hrs for 3 ferries TOTAL = 12,896 hrs/year
# ferries in fleet:	currently 3, next month they will add one more (average running time will not change, just be redistributed between 4 ferries)
Age of ferries:	3 are 9 years old, 1 will be new next month
Average cruising speed:	10 knots At 10 knots, they run at 70% capacity
hp	240 hp each single engine
% time cruising vs. idling	Of running hours, 95-97% of the time is cruising, the rest idling (engines are ON at the dock)

No other information was available on the Fort Lauderdale Water Taxi.

15.3 DELAWARE RIVER FERRIES

Unlike the Puget Sound and New York areas, the major cities along the Delaware River such as Philadelphia and Camden rely mostly on bridges for transit across the river and harbor and thus, have much more limited ferry services. The primary Delaware River area ferry operators are thus much smaller than those discussed in Section 15.1 and 15.2, and do not serve as primary commuter transit modes. The ferries which do serve this area are the Cape May-Lewes Ferry, the Three Forts Ferry Crossing, and the Rehoboth Bay Shuttle.

The Philadelphia area ferries are detailed by operator in the tables below. Information in Tables 15-8 and 15-9 include, if possible, information on: each route and vessel include, average one-way trip time in minutes, number of weekday as well as weekend and holiday trips, average running time calculated out to hours per year, number of ferries in the operator's fleet, average vessel cruising speed, horsepower, and percent of time idling vs. cruising. Any additional relevant data are also included.

15.3.1 Cape May-Lewes Ferry

The Cape May-Lewes Ferry is an auto/passenger ferry which runs a 70-minute boat ride connecting Lewes, DE and Cape May, NJ. A complete trip includes the 70-minute cruise, 10-minutes maneuvering into dock and 20 minutes hotelling at the dock. Operating year-round, the schedule for this route varies with the season. A small proportion of trip are moonlight cruises in the summer with live entertainment, and other special events. Run by Delaware River and Bay Authority, the ferry operates out of the Terminal Building in

Cape May, NJ. Contacts are Jim Salmon, Public Relations (302) 571-6409 and Rich Woehlcke, Port Engineer (609) 889-7225.

Table 15-8. Cape May-Lewes Ferry

Route: Lewes, DE - Cape May, NJ	
Average one-way trip:	70 minutes
TOTAL annual trips:	5820 [1]
Average cruising time:	6790 hours/year
Average idling time:	Average 20 minutes each idling event 970 hours/year
Average maneuvering time:	Average 10 minutes/trip maneuvering 970 hours/year
# ferries in fleet:	5
Ferry fleet age:	MV Twin Capes - 23 yrs old (1975) MV Delaware - 24 yrs old (1974) MV New Jersey - 24 yrs old (1974) MV Cape Henlopen - 17 yrs old (1981) MV Cape May - 13 yrs old (1985)
Average cruising speed:	12.5 knots, which is 75% of maximum capacity 15-16 knots (75% is optimum fuel consumption for the schedule they run)
hp	4000 (total for two engines)

[1] Minimum annual trips predicted for 1998. 1997 had 6,341 and 1996 had 6,200 annual trips

Runs are very heavily seasonal with the following predictions for annual operation:

- Offseason (mid-Oct to mid-May) = 6 round trips/day
- Base season (June to Sept) = 12 round trips/day
- Peak days (e.g. Saturdays) = 21 round trips/day

15.3.2 Three Forts Ferry Crossing

The Delaware River and Bay Authority also runs the Three Forts Ferry Crossing. The ferry is passenger only, and is run primarily as a park visitor service. Contact at Fort Delaware Park is Jim Harris, Captain and Supervisor of Ferry Operations, call phone: 302-584-1574

Table 15-9. Three Forts Ferry Crossing

Route: Fort Mott State Park to Pea Patch Island to Delaware City	
Average one-way trip:	30 minutes
# trips:	N/A - No set schedule - runs mostly on demand, typically picks up on the half hour
Average running time:	Runs continuously (12 hours), 5 days/week (Wed -Sun) 3120 hours/year
# ferries in fleet:	1, holds 88 passengers (adding one more in 1999)
Average cruising speed:	10 knots
hp	Each of two engines is 275 hp = total 550 hp
% time cruising vs. idling	Turns around at the dock immediately - no substantial idling time

15.3.3 Rehoboth Bay Shuttle

Also running in the Philadelphia area is the Rehoboth Bay Shuttle, serving only one route which connects Long Neck to the Rehoboth Beach-Dewey Beach area. Call for schedule and additional information. (302) 645-9380. An average one-way trip is 27-minutes. The shuttle operates daily, weather permitting, Memorial Day-Labor Day, with extended hours on weekends. Special charters are available. No further information was available on fleet size, annual number of trips or running time.

SECTION 16

RECOMMENDATIONS

This section discusses further work required to quantify and qualify the commercial marine inventory for the United States. Some tasks must be completed before the default inputs for the NONROAD model can be developed. All of these recommendations are complimentary to the work already performed in this Work Assignment. The recommendations pertain to the following:

1. Auxiliary engine characterization
2. Characterization of mooring tug operation
3. River traffic on the Mississippi and Ohio Rivers
4. Lake traffic within the Great Lakes
5. Commercial fishing vessels and activity
6. Dredging vessels and activities
7. Distances from the breakwater to the port for each of the Top 95 DSPs
8. Electronic maps
9. Guidance document

Auxiliary engines are on most deep-sea vessels and are the largest source of hoteling emissions and a significant source during manuevering. Auxiliary engines are used for loading and unloading and power generation on the ship. Some limited work was done on auxiliary engines in the South Coast Marine report (Reference 1-1). Lloyds Maritime Information Service (LMIS) have auxiliary engine data on about 20% of the world fleet. They have a database on about 22,000 engines. The price of the entire database is $1,530. If we sent them the LMIS numbers that we have, the cost for supplying auxiliary engine data would be about $1,088. LMIS figures they would be able to match about 20% of our LMIS numbers to auxiliary engine data.

Mooring tug operation at the Deep-Sea Ports, may account for a large percentage of the emissions that occur close to land. Unfortunately, neither the USACE nor the MEPAs regularly track mooring tug operations. It may be possible to apply a rule-of-thumb, based on ship-type, to determine the average number and time-in-mode for mooring tugs. It would be better to have actual data on mooring tugs and have these vessels tracked within the port.

While in Volume II of this report we have detailed river and lake traffic at two river ports and two lake ports, general river and lake traffic is not covered. There are substantial distances on the Mississippi and Ohio rivers that are not covered by ports and could be a significant emissions source. Using lock data and additional USACE data, we could present a more thorough picture of activity on the inland rivers. In addition, significant lake traffic occurs in the shipping lanes on the Great Lakes that is not characterized in our current study. This could also be a significant source of emissions that are transported to local non attainment areas that need to be characterized. With additional USACE data, we could also characterized general Great Lake traffic.

Fishing activity was investigated and several possible methodologies were discussed. Very few ports keep records on fishing boat activities. These most likely need to be determined from fishing boat operators and state departments of fish and game. Efforts were invested in contacting the Washington Department of Fish & Game which provided information on fishing licenses and tons of fish caught. Extrapolation of this data is difficult since tons of fish caught, as recorded by USACE, are given without distinguishing the type of fish. Also USACE only records this data for regions rather than ports. Furthermore, fishing license information is not specific or complete enough to detail vessel activity. More vessel oriented information is needed, however, to detail fishing vessel activity.

Some attempts were made to determine dredging activity from the USACE. USACE coordinates most of the dredging in ports and rivers. The LMIS data has some information on dredges and together with USACE data on dredging schedules at the "typical" ports, dredging activity could be characterized.

Although distances from the breakwater to each of the Top 95 DSPs could be determined by measuring the distance on a map, some port areas are more complex than others and calls to each of these complex ports will allow a more accurate distance from the point of picking-up the pilot which is usually where the RSZ begins.

Additional items to help the user of this report might include maps in electronic form that are imported into the document. Electronic maps focusing on the major geographic features of ports and waterways are not as readily available as street maps but through a combination of INTERNET map sites, cooperation with various Port Authorities, and scanning of available paper maps, maps showing the breakwater, ports, major geographic features and other reference points often referred to in this report could be obtained and included herein.

Furthermore, a guidance document should be written for the user of the NONROAD model to facility the user in providing marine activity information more specific to their port. As ARCADIS Geraghty & Miller searched for information on detailed vessel activities and port descriptions, it became apparent that a great deal of variability exits between ports as to what data are recorded at what level of completeness. A guidance document could greatly assist the Port Authorities in obtaining information relevant to the model.

ARCADIS Geraghty & Miller can provide all these services and would be happy to discuss these recommendations and future work with EPA.

SECTION 17

REFERENCES

SECTION 1 - INTRODUCTION

1.10 Pera, Charlotte J. Marine vessel emissions inventory and control strategies. Mountain View, CA: Acurex Environmental Corporation; 1996; Prepared for South Coast Air Quality Management District.

1.11 Pera, Charlotte and Diana Popek. Update to Marine Vessel Emissiosn Inventroy and Control Strategies. Mountain View, CA: ARCADIS Geraghty & Miller, Inc. 1999; Prepared for South Coast Air Quality Management District

SECTION 2 - TOP 90 DEEP-SEA PORTS

2-1 United States Army Corps of Engineers, Waterborne Commerce Statistics Center, PO Box 61280, New Orleans, LA

2-2 United States Waterway Data CD-ROM, Bureau of Transportation Statistics, US Department of Transportation, 400 7th St. S.W. Room 3430, Washington, D.C. 20590

SECTION 6 - LOWER MISSISSIPPI RIVER, GULF TO BATON ROUGE

6-1 New Orleans Board of Trade, Gene Hymel, 504-525-3271

6-2 Crescent River Pilots, Mike Bucollo, 504-392-8001

SECTION 7 -CONSOLIDATED PORT OF NEW YORK AND NEW JERSEY INCLUDING ALBANY

7-1 NY/NJ Marine Exchange, Philip, 212-425-5704

7-2 Sandy Hook Pilot Company, Bob Dean, 718-448-3900

SECTION 8 - DELAWARE RIVER PORTS INCLUDING PHILADELPHIA, PA

8-1 Philadelphia Maritime Exchange, Scott Anderson, 215-925-1524

8-2 Pilot's Association for the Delaware River and Bay, Captain Bock, 215-922-7165

SECTION 9 - PORTS OF THE PUGET SOUND INCLUDING SEATTLE, WA

9-1 Marine Exchange of the Puget Sound 800-627-3924. POC - Jim Friberg

9-2 Puget Sound Pilots, Port Angeles Pilot Station, 305 Ediz Hook Road, PO Box 788, Port Angeles, WA 98362, 800-221-0234. POC – Captain Bill Bock

9-3 The Port of Seattle, Port Series Report

9-4 Port Angeles, Port Series Report

SECTION 10 - PORT OF CORPUS CHRISTI, TX

10-1 Corpus Christi Port Authority, 512-882-5633, Danny Hodgains, Director of Finance

10-2 Corpus Christi Pilots Association, 512-888-6230, Louis Adams, President and pilot

SECTION 11 - PORT OF TAMPA, FL

11-1 Tampa Port Authority, 813-272-0555, Lori Rafter

11-2 Tampa Pilotage Authority, Tampa Bay Pilots, 5103 S. Westshore Blvd., Tampa, FL 33611, 813-805-0270,

SECTION 12 - PORT OF BALTIMORE, MD

12-1 Baltimore Maritime Exchange, David Stanbaugh, 410-342-6610

12-2 Association of Maryland Pilots, 3720 Dillon St., Baltimore, MD 21224, 410-342-6013

SECTION 13 - PORT OF COOS BAY, OR

13-1 Coos Bay Marine Exchange on the Columbia River, Liz Wainwright, 503-228-4361

13-2 Port of Coos Bay, Martin Callery, 541-267-7678

SECTION 15 - FERRY CHARACTERISTICS AND OPERATIONS

15-1 Washington State Ferries, Seattle, WA

15-2 New York City Department of Transportation, 718-390-5253

15-3 Express Navigation, Gary Duzleman, 732-872-2628

15-4 New York Waterways, R. Bostick, 201-902-8841

15-5 Prospect Fast Ferry, Doreen, 732-872-1450

15-6 Fort Lauderdale Water Taxi, Doug Fried, 201-985-1164

15-7 Cape May-Lewes Ferry, Jim Salmon, 302-571-6409

APPENDIX B - PORT CULTURE FOR DEEP SEA PORTS[1]

[1]The main source of data for all Appendix B text are the Port Series Reports produced by the US Army Corps of Engineers, Water Resources Support Center for each waterway discussed. These Port Series reports are commercially available from the Water Resources Support Center, Casey Building, Fort Belvoir, VA 22060.

APPENDIX A

DATA FIELD DESCRIPTIONS

Table A-1. Lloyds Maritime Information Service fields and descriptions

LMIS Field	Description
Vessel	Current trading name of vessel
Ship Type - A	Ship type classification as defined for Lloyds Register Statistical Tables
Ship Type - B	More detailed ship type classification
Ship Type -C	Most detailed ship type classification
Lr No	The unique Lloyd's register identity number.
Steam Turbine	Number of steam turbines
Stroke Type	2 stroke, 4 stroke, or blank (for steam turbines)
DWT	Summer deadweight tonnage
BHP	Power in brake horsepower of new or refurbished engines
Speed	Service speed of the vessel
RPM	RPM at service speed
Consumption	Fuel consumption
DOB	Year in which the vessel was delivered to the fleet or last date of engine refurbishment
Ind	Ship status indicator
Ship Status	Description of ship status
Design	Name of company that manufactures the main propulsion engines
Designation	Engine designation
Recip - Kw	KW produced by the steam turbines
Gas Turb	Number of propulsion gas turbines on board
Flag	Flag of country where the vessel is registered
Best Address	Parent company where available, or manager, or owner.
LR number supplied	Yes indicates that this record was generated from a Lloyds registry number supplied by ARCADIS Geraghty & Miller to LMIS No indicates that this record was generated from a ship name only.

Table A-2. Army Corps of Engineers Data 1995 file and field data vessel movement data

Data Field	Description
acurrvld	File name for loaded receipts. These are vessels coming into port with cargo
acurrvlt	File name for light receipts. These are vessels coming into port without cargo
acurshld	File name for loaded shipments. These are vessels leaving the port with cargo
acurshlt	File name for light receipts. These are vessels leaving the port without cargo - These files are cargo specific so that the same vessel could be recorded several times in different files without double counting trips
COE Field	**Description**
PCODE	Port code used by the COE to represent ports and waterways in the United States
PORT_NAME	Name of the port
SH_RC_DATE	Date of shipment receipt
TRAFFIC	Traffic code indicates the type of shipment or receipt by origin
VTYPE	Single digit vessel type code: 1 = Motor dry cargo and steam dry cargo 2 = Motor tanker and steam tanker 3 = Tug 4 = Barge - dry cargo 5 = Barge - tanker 6 = Other including yacht, sloop, schooner, sailboat, houseboat, rowboat, and
VESS_TYPE	Four digit vessel type construction and characteristics (VTCC) code
TONS	Tons shipped or received
TRIPS	One-way entrance or clearance from a PCODE

Source: Waterborne Commerce Statistics Center in New Orleans, LA

Table A-3. USACE Data on Foreign Ships from USWWCD and the Census Bureau.

Data Field	Description
STAT MONTH	Represents the month in which the vessel entrance or clearance was processed. The porcessin month is almost always the same month as the physical movement of the vessel
WTWY	Port or waterway code used by the COE to represent ports and waterways in the United States
VESS_NAME	Vessels full name up to 36 characters
ICST	International Classification of Ships by Type code indicates the ship type. If the ICST code is not available, the Census Bureau's 1 digit rig code is used as follows: 1 = Motor dry cargo and steam dry cargo 2 = Motor tanker and steam tanker 3 = Tug 4 = Barge - dry cargo 5 = Barge - tanker 6 = Other including yacht, sloop, schooner, sailboat, houseboat, rowboat, and research
FLAG	Vessel's flag of registry
WTWYSCHEDK	Indicates the vessel's last port of call for an "entrance" or the next port of call for a "clearance". If the port if foreign the field contains the port's 5 digit schedule K code. If it is domestic, it contains the COE's 4 digit port or waterway code.
PORT_IND	Indicates a domestic port by a "D" in the field. Otherwise the port is foreign
NRT	Net registered tonnage of the vessel
DRAFT	Indicates the vessel's draft in feet

Source: Data submitted to the Census Bureau by the Army Corps of Engineers for publication on the United States Waterway Data CD-ROM for 1995

A-4. Details of information received from the New Orleans Board of Trade (BOT) for vessel traffic on the Lower Mississippi River

BOT Field	Description
Shipname	Current trading name of vessel
lloyds	Lloyds Register Number
callsign	Vessel call sign
flag	Flag of country where the vessel is registered
dwtons	Dead weight tonnage
lengthoa	Overall vessel length
type	Vessel type indicator: BB = break bulk BC = bulk carrier CB = container barge CS = container ship CT = chemical tanker GC = general cargo LA = LASH (lighter aboard ship) LG = Liquified flammable gas carrier LN = Liquified natural gas carrier NC = other OO = ore/oil carrier PA = passenger RC = refrigerated cargo (Reefer) RE = research vessel RO = roll on/roll off (RORO) SP = supply ship TG = tug TK = tanker WC = wood chip carrier
speed	Service speed of vessel (cruising speed)
agent	Vessel agent
passdock and pass_num	Pass of entry to the Mississippi: 5 = Southwest Pass at mile 0, 6 = South Pass at mile 0, 7 = Mississippi River Gulf Outlet at mile 9.3
passdate	Date the vessel passes the dock of entry
passtime	Time the vessel passes the dock of entry
pass_ea	Pass indicator field, E = estimated time at pass, A = actual time at pass
plotdock or plot_num	Dock where the Crescent River pilot meets the vessel 101 = Pilottown at mile 2, 520 = light 78 at mile 28.3
plotdate	Date the vessel picks up the pilot
plottime	Time the vessel picks up the pilot
deptdock	Last dock for the vessel before heading back out to the Gulf
deptdate	Date of departure from the last dock
depttime	Time of departure from the last dock
dept_ea	Departure indicator field, E = estimated time at pass, A = actual time at pass
feetin	Inbound draft to the nearest foot
inchin	Additional inbound draft in inches
feetout	Outbound draft to the nearest foot
inchout	Additional outbound draft in inches
docking	Destination dock code
bpcomments	Comments may include destination docks not included in a data field

A-5. Details of information received from the Marine Exchange for the Consolidated Port of New York and Ports on the Hudson River Including Albany, NY

Marine Exchange Field	Description
VESSEL	Current trading name of vessel
FLAG	Flag of country where the vessel is registered
PROP	Propulsion type indicator: M- Motor or S - Steamship
RIG	Ship type indicator: B = bulker BC = barge carrier BCC = bulk/container carrier BO = ore/oil/bulk carrier CABL = cable layer CC = container ship CEMT = cement carrier CT = chemical tanker HL = heavy load carrier HLC = heavy load carrier LPG = liquified gas tanker MVEH = vehicle carrier OO = ore/oil carrier PASS = passenger PCC = passenger/container ship REF = refrigerated cargo (Reefer) RO = roll on/roll off (RORO) ROCC = RORO/ container ship S = freighter/general cargo T = tanker TK = tanker VEH = vehicle carrier WC = wood chip carrier
CALLSIGN	Vessel's callsign
AGENT	Vessel's agent
ARR_DATE	Date of arrival at Ambrose or City Island
AMB_TIME	Time of arrival at Ambrose, blank if arrival is at City Island
CTYIS_TIME	Time of arrival at City Island, blank if arrival is at Ambrose
TUG_IN	Letter indicating the tug company called to assist with docking at the first berth. A blank field is an indicator of no data available
TYPE_CARGO	Indicates ship type and cargo type
BERTH	Name of first berth. The most popular with the approximate times from Ambrose are: Port Elizabeth = 2.3 Port Newark = 2.5 Stapleton (anchorage) = 1.3 Bay Ridge Flats = 1.2 Red Hook Marine = 2.3 Global Marine Terminal = 2.3 Jersey City = 2.6 Maneuvering into the berth will, on average, add another 0.5 hours
TRNS_DATE1	Date of transition between the first berth and the second berth
TRNS_TIME1	Time during the transition between the first berth and the second berth. Not necessarily the time clearing or tying up, just sometime during the transition.
BERTH_2	Name of the second berth, if applicable
TUG_2	Letter indicating the tug company called to assist with docking at the second berth.

A-5. Details of information received from the Marine Exchange for the Consolidated Port of New York and Ports on the Hudson River Including Albany, NY - Concluded

Marine Exchange Field	Description
TRNS_DATE2	Date of transition between the second berth and the third berth
TRNS_TIME2	Time during the transition between the second berth and the third berth.
BERTH_3	Name of the third berth, if applicable
TUG_3	Letter indicating the tug company called to assist with docking at the third berth.
TRNS_DATE3	Date of transition between the third berth and the fourth berth
TRNS_TIME3	Time during the transition between the third berth and the fourth berth.
BERTH_4	Name of the fourth berth, if applicable
TUG_4	Letter indicating the tug company called to assist with docking at the fourth berth.
TRNS_DATE4	Date of transition between the fourth berth and the fifth berth
TRNS_TIME4	Time during the transition between the fourth berth and the fifth berth.
BERTH_5	Name of the fifth berth, if applicable
TUG_5	Letter indicating the tug company called to assist with docking at the fifth berth.
TRNS_DATE5	Date of transition between the fifth berth and the sixth berth
TRNS_TIME5	Time during the transition between the fifth berth and the sixth berth.
BERTH_6	Name of the sixth berth, if applicable
TUG_6	Letter indicating the tug company called to assist with docking at the sixth berth.
DEPART_DTE	Date of departure from the last berth
OUT_AMBR	Date of departure from Ambrose, blank indicates a City Island departure or not data
OUT_CTYIS	Date of departure from City Island, blank indicates an Ambrose departure or no data
TUG_OUT	Letter indicating the tug company called to assist with clearing the last berth
NEXT_PORT	Gives the name of the next expected port, either city if in the US or country if foreign
LLOYDS_NO	Lloyds Register Number
NET_TONS	Net tonnage
GROSS_TONS	Gross tonnage
DWT_TON	Deadweight tons in metric tonnes

A-6. Details of Information Received from the Maritime Exchange of the Delaware Bay and River

Marine Exchange Field	Description	
VESSEL	Name of Vessel	
FLAG	Flag of registry	
FROM	Last port of call	
RIG	Ship type indicator: BO = break oil BU = bulk carrier CC = container CT = chemical tanker GC = general cargo/break bulk LG = liquid gas	OO = ore/bulk/oil PF = Passenger RO = RORO SP = specialized carrier/refrigerated TA = tanker VE = vehicle carrier
AGENT	Vessel agent	
ARRIVED	Date the vessel arrives at the breakwater	
TIME_BW_CD	Time the vessel crosses the breakwater	
TIME_ANCH	Time the vessel anchors	
TIME_UP	Time the vessel weighs anchor	
ANCHORAGE	Place of anchorage: BBH = Bombay Hook at mouth of Delaware River BSB = Big stone Beach just above breakwater - lightering BW = Breakwater - awaiting berth KPA = Kaighn's Point Anchorage just below Philadelphia - awaiting berth MCA = Mantua Creek Anchorage near Paulsboro - bunkering MHA = Marcus Hook Anchorage - bunkering RDY = Reedy Point at entrance to C&D Canal - awaiting berth WIL = Deepwater Point at Wilmington - awaiting berth	
TIME_MH	Time the vessel passes Marcus Hook which is 70 miles after the breakwater and not necessarily an anchorage or berth	
PIER	Pier of first docking. Most common with approximate times from BW are: POW = Port of Wilmington, 4.5 hours PENN TERM = across river from Paulsboro, 5.5 hours GLOUCESTER = just south of Camden, 7 hours SUN MH = Sun Terminal at Marcus Hook, 5 hours PACKER AVE = Philadelphia pier, 8 hours CAMDEN TERM = Camden terminal, 8 hours TIOGA = Upriver from Philadelphia, 9 hours DELWRE CITY = Delaware City, 4-5 hours MOBIL PAULS = Mobil Paulsboro 5.5 hours EAGLE POINT = Downriver of Gloucester, 6 hours	
DOCKED	Date vessel docks at first pier	
SHIFT_A	Destination pier for the first shift	

A-6. Details of Information Received from the Maritime Exchange of the Delaware River (Concl'd)

Marine Exchange Field	Description
DATE_A	Date of shift to the pier given in SHIFT_A
SHIFT_B	Destination pier for the second shift
DATE_B	Date of shift to the pier given in SHIFT_B
SHIFT_C	Destination pier for the third shift
DATE_C	Date of shift to the pier given in SHIFT_C
MISC_INFO	Varied notes that may include details of tug assist, destination times, notes on repairs etc.
REANCHOUT	Time a vessel anchors if an anchorage occurs on the outbound trip
SHIFT_D	Destination pier for the fourth shift
DATE_D	Date of shift to the pier given in SHIFT_D
U_WAY_OUT	Time the vessel gets underway from an outbound anchorage
OUT_BW	Time the vessel exits the breakwater
SAILED	Date the vessel gets underway for the outbound trip
NEXTPORT	The next port of call
TUGS	Abbreviation of the tug company used to assist the vessel. The major abbreviations are: MCA = McAllister (215-922-6200) MRN = Moran (215-755-4702) TUR = Turecamo (215-925-5865) WTL = Wilmington (302-652-1666)
ORDER	Written notes on orders to shift or dock, some times included
LOADED	Description of cargo loaded
DISCHARGED	Description of cargo discharged
DRAFT	Draft of the inbound vessel in feet
SAILING	A list of one, two, or three times. The first time is the time the vessel leaves the last dock, the second time is the time the vessel passes Marcus Hook, the third time is the estimated time the vessel will exit the breakwater. If only two times are given, the second time is likely the time the vessel passes Marcus Hook, but this data should be used carefully.
UP_DRAFT	Draft of departing vessel. Often not reported.
ETA	Estimated time of the vessel's arrival at the first dock or anchorage
GROSS	Gross tons
NRT	Net registered tons or actual tons of cargo registered to be on the vessel
DWT	Deadweight tons or the maximum cargo carrying capacity in tons
LENGTH	Overall length of the vessel in feet
BREADTH	Overall breadth of the vessel in feet

A-7. Details of Information Received from the Marine Exchange of the Puget Sound

Marine Exchange Field	Description
VSLNAME	Vessel Name
LLOYDS	Lloyds Maritime Information Service unique identification number
FLAG	Flag of the country where the vessel is registered
AGENT	Vessel agent
PORT	Port of call in the Puget Sound Area identified for each leg of a trip within the Puget Sound
PIER	Name or number designation for the pier at the port of call in the Puget Sound area
CARGO_DISC	Description of cargo discharged at the port
CARGO_LOAD	Description of cargo loaded at the port, does not include bunkering
O_S_LPOC	Last port of call, name of country if foreign, name of city if US, and name of pier if within the Puget Sound
O_S_NPOC	Next port of call, name of country if foreign, name of city if US, and name of pier if within the Puget Sound
SHIFT	Indicates if record is a shifting activity within the Puget Sound
BUNKER	"Yes" or "No', indicates if the vessel took on fuel while at the port and pier
PLTADA	Harbor pilot's actual day of arrival on the vessel, "DIR" means no pilot
PLTATA	Harbor pilots actual time of arrival on the vessel, twenty-four hour scale
PLTADD	Harbor pilots actual time of departure from the vessel, MM/DD/YY
PLTATD	Harbor pilots actual time of departure from the vessel, twenty-four hour scale
PORTADA	Actual day of arrival in port, MM/DD/YY
PORTATA	Actual time of arrival in port, twenty-four hour scale
PORTADD	Actual day of departure from port, MM/DD/YY
PORTATD	Actual time of departure from port, twenty-four hour scale
TUGIN	Indicates which tug company brought the vessel into the pier
REMARKS	Comments including bunker (B), offload (O), repairs, or anchorage
NO_IN	Number of tugs used to bring the vessel into the pier
NO_OUT	Number of tugs used to assist the vessel out from the pier
AMT_BUNK	Gallons of fuel bunkered
TYPE_BUNK	indicates the type of fuel bunkered, either intermediate fuel oil (IFO) or CST
TUGOUT	Indicates which tug company brought the vessel into the pier
MDO	Marine diesel oil, a lighter fuel than bunker "C"
SUPPLIER	Name of company supplying fuel
HAZARDOUS	Indicates if cargo is hazardous
DEPARTURE	Indicates if the vessel is leaving the present pier to shift to another pier or to depart the waterways of the Puget Sound

A-8 Details of information received from the Port Authority of Corpus Christi

Corpus Christi Field	**Description**
Lloyds Number	Lloyds Register Number
Name	Vessel name
Dead Weight	Dead weight tonnage
Vessel Type	Vessel type indicator: L = liquid D = dry bulk B = both
Arriv_Time	Arrival time at the dock
Arriv_Date	Arrival date at the dock
Dep_Date	Departure date from the last dock
Dep_Time	Departure time from the last dock
Cargo	Description of cargo
Activity Type	Activity type indicator usually for loading and unloading cargo
Activity Description	Description of activity type indicator

A-9. Details of Information Received from the Tampa Bay Port Authority

Port Authority Field	Description	
TYPE	Vessel Type Description: BO = Barge, liquid BP = Barge, petroleum BQ = Barge, petroleum >500' BX = Barge (RE/ID/BU) CL or CS= Cruise ship CX = Cruise ship (RE/ID/BU) MD = Dry Bulk Cargo, Motor MG = General Cargo, Motor MO = Other liquid, Motor	MP = Tanker, Motor MX = Motor (RE/ID/BU) RR = roll on/roll off (RORO) RV = Research vessel SO = Other liquid, steam SP = Petroleum, steam SX = Steam (RE/ID/BU) SY = Ships/Yachts/Boats TG = Tug TX = Tug (RE/ID/BU)
Vessel_Name	Current trading name of vessel	
Gross Tons	Gross tonnage	
Flag	Flag of registry	
Activity	Activity descriptor field: RE = Repair, ID = Idle, BU = Bunkering, NA = normal activity	
Status	Indicates the vessel movement for this record: Arr = Arrival from open ocean, Sft = shift within the port, Dep = Departure to open ocean	
Port	Indicates if the vessel came to a port at that leg of the journey	
Berth	Number code of the berth or anchorage the vessel called on for that record in the dataset	
Arrival Date	Date of arrival at Berth	
Arrival Time	Time of arrival at Berth	
Departure Date	Date of departure from Berth	
Departure Time	Time of departure from Berth	
Term Op	The scheduled terminal operator	
Stevedore	The schedule stevedore	
Cargo	Description of the type of cargo carried, i.e. gas, scrap metal, or liq. propane	

A-10. Details of Information Received from the Maryland Port Authority for Ports on the Patapsco River Including Baltimore Harbor, MD

Port Authority Field	Description	
VES_NAME	Name of vessel	
NON COUNT	Indicates if the vessel did not require a local pilot. Usually for military vessels.	
FLAG	Flag of the country where the vessel is registered	
AGENT	Vessel's agent	
TUGS	Company called for tug assist into the berth	
LINES	Company called for tying up the vessel at the berth	
LRN	Lloyd's Register Number	
SHIP_TYPE	Ship type indicator: BULK = bulk carrier CABLE = cable layer CEMENT = cement carrier CONT = container ship GC = general cargo GC/FP = general cargo/freighter NAVAL/GC = navy /general cargo OBO = ore/bulk/oil carrier	PASS = passenger PASS/GC = passenger/general cargo REF = refrigerated cargo RORO = roll on/roll off (RORO) TANK = tanker TANK (CHEM) = chemical tanker TUG = tug TUG/BARGE = tug/barge combined VEH = vehicle carrier
LOA	Overall length of the vessel	
BEAM	Overall width of the vessel	
GRT	Gross registered tons	
A_DATE	Arrival date at North Point	
NPT_TIME	Time of arrival at North Point. North Point is 4.1 miles from the Francis Scott Key Bridgeand is the point for picking up tugs and pilots.	
A_DRFT	Arrival draft in feet and inches	
FED_PILOT	Indicates if a federal pilot rather than a harbor pilot was used	
A_ROUTE	Arrival route. C/H indicates arrival from Cape Henry in the south. C/D indicates arrival from the Chesapeake/Delaware Ship Canal in the north	
LAST_PORT	Last port of call. Country if foreign; city if in the US.	
ANNA_DATE	Date of anchorage at Annapolis, if any	
ANNA-TIME	Time of anchorage at Annapolis	
ANNA_UW	Time underway from anchorage at Annapolis	
BERTH_#1	Indicator of the vessel's first berth in the Baltimore area. Some of the major berths are: DMT = Dundalk Marine Terminal NLPT = North Locust Point Marine Terminal SLPT = South Locust Point Marine Terminal SEAGIRT = Sealand Service, Seagirt Terminal Wharf ALTERM = Atlantic Marine Terminal	

A-10. Details of Information Received from the Maryland Port Authority for Ports on the Patapsco River Including Baltimore Harbor, MD (continued)

Port Authority Field	Description
TUGS_#1	Time and date vessel comes to anchorage. If DOA is given, the vessel "docked on arrival" and proceeded to dock with tug assist taking approximately 1 to 1.5 hours form NP to dock and tie up.
BERTH_#2	Indicator of the vessel's second berth in the Baltimore area.
TUGS_#2	Time and date vessel comes to anchorage. If DOA is given, the vessel "docked on arrival".
BERTH_#3	Indicator of the vessel's third berth in the Baltimore area.
TUGS_#3	Time and date vessel comes to anchorage. If DOA is given, the vessel "docked on arrival".
BAL_ANCH	Indicator for one of 5 Baltimore anchorages
B_ANCH_DATE	Date of anchorage
B_ANCH_TIME	Time coming to anchorage
B_ANCH_UW	Time underway from anchorage
D_DATE	Departure date from North Point
PILOT_ORD	Time the tugs and the pilot are scheduled to meet at the ship to escort it out of the harbor
NPT_OUT	Time clearing North Point on the departure
D_DRFT	Departure draft in feet and inches
D_ROUTE	Departure route indicated same as arrival route
NEXT_PORT	Next port of call; country for foreign, city for domestic
REMARKS	Remarks contain information on any other shifts and anchorages and possible explanations of ship activities in port such as repair

A-11. Details of Information Received from the Coos Bay Marine Exchange

Marine Exchange Field	Description
SHIP NAME	Current trading name of vessel
ETA	Date of arrival in Coos Bay
ARRTIME	Time of arrival at Berth
ETD	Date of departure from Coos Bay
DEPTIME	Time of departure from Berth
AGENT	Vessel agent
BERTH	Name of destination dock. The following are the docks and the average time from the breakewater to the dock: Central Dock 1.75 Coos Bay Docks 2 Dolphin Terminals 1.75 Export Services 1.5 Georgia Pacific 2 Glenbrook Nickel 2 Ocean Terminals 1.5 Oregon Chip Terminal 1.6 Roseburg Lumber 1.2
GROSS	Gross registered tonnage of the vessel
COOSBAY_NET	Net tonnage loaded or unloaded in Coos Bay
Oil Engines	Number of oil engines. Blank indicates no data

APPENDIX B

DETAILED PORT INFORMATION

APPENDIX B.1

DETAILED PORT INFORMATION ON THE PORTS OF THE LOWER MISSISSIPPI RIVER GULF OUTLET TO BATON ROUGE, LA

B.1.1 GENERAL

The Mississippi River empties into the north central part of the Gulf of Mexico through a number of mouths or passes which, taken together, form the delta of the river. The river and its tributaries constitute the largest network of navigable waters in the world. The two principal passes, South Pass and Southwest Pass, are about 1,600 nautical miles from New York, 500 nautical miles from Key West, 300 nautical miles east of Galveston, and 440 nautical miles east of Corpus Christi. The river is the access to the Ports of New Orleans and Baton Rouge, and numerous cities located in the Mississippi River Valley and along its tributaries. New Orleans can also be reached by the more direct deep-draft route through the Mississippi River-Gulf Outlet Canal, about 30 miles north of South Pass. The outlet canal extends from deepwater in the Gulf to the junction with the Inner Harbor Navigation (Industrial) Canal at New Orleans.

From Head of Passes to New Orleans, the river has a least width of 600 yards and a clear unobstructed channel with depths of from 31 to 194 feet, with a few shoals along the river banks. At Head of Passes, three of the river's important passes come together, South Pass, Southwest Pass, and Pass a Loutre. From this point of confluence, measurement is made of all distances on the river south or below the mouth of the passes, and north or above Head of Passes (AHP). The distance from the Head of Passes to the Gulf of Mexico is 20 miles via Southwest Pass and 13 miles via South Pass. The mouth of South Pass is 18.5 miles northeast of the mouth of Southwest Pass. Pass a Loutre and its branches flow east into the Gulf. These passes are deep from the Head of Passes to within a short distance of the Gulf, but the mouths are obstructed by sand bars.

The shape of the delta is somewhat like the foot of a bird, with its four toelike extensions protruding into the Gulf. The passes consist of narrow-banked deposits of sand and clay brought down by the river current which continuously adds them to the seaward margins of the delta. In this manner the delta is being built seaward at an estimated average rate of 300 feet a year. Numerous bays between the passes are changing through wave and tidal action and filling up with the immense amounts of material carried down by the river. Flocculation, locally known as slush, is a living mass of jellied material, or muck, deposited in the lower part of the river during low stages. It consists of the suspended material which, after being carried downstream by the current, comes into contact with the relatively still salt water which backs into the passes. This suspended material, observed to be as much as 10 to 15 feet deep, remains until flushed out during high-water stages. Although slowed down by this muck, deep-draft vessels are able to pass through it so the Corps of Engineers does not consider it necessary to remove the material during low stages.

Sand waves, the material brought down during high stages, is of a sandy nature and if not removed, builds up bars and reduces controlling depths. These sand bars or waves are dredged out during high stages. Mud lumps are small oval-shaped mounds or islands no more than 8 feet high which are peculiar to the Mississippi River delta. They are caused by upward forces of the static pressure exerted by sedimentary deposits accumulating underneath. Most of them never rise above the surface but remain as subsurface mounds. Their cores of plastic clay may arise from depths as much as 300 to 500 feet. Fissures or cracks develop in the islands, through which mud, gas, and salt water discharge and often build up low flat cones. In the South and Southwest Passes, which have been jettied, there are arcs of mud lumps outside of and parallel with the peripheries of the bar deposits. Generally, the lumps appear within a few weeks of time and, unless affected by succeeding periods of uplift, will wash away within a few years or be overrun by the encroaching marshland.

The improved ship channels into the Mississippi River are through Southwest Pass and South Pass. A federal project provides for a 45-foot channel over the bar and through Southwest Pass, to Head of Passes. A 45-foot channel proceeds from Head of Passes to New Orleans, then on to Mile 181 above New Orleans. A 40-foot channel proceeds from Mile 181 to Baton Rouge. All channels are well marked and constantly maintained by dredging. The river channel between New Orleans and Baton Rouge is for the most part deep and clear. However, at low river stages, there are sections of the river that have been improved by dredging to accommodate deep-draft vessels. These sections, 13 in all, are called crossings and are situated along the river from Fairview at 114.8 miles AHP to Baton Rouge at 230.7 miles AHP. The depths for the crossings is 45 feet to mile 181 AHP and then 40 feet to Baton Rouge.

The Mississippi River-Gulf Outlet Canal is a 66-mile long deepwater channel that extends northwest from deep water in the Gulf of Mexico to the Inner Harbor Navigation Canal at New Orleans. The Outlet Canal channel is 38 feet deep for 8.3 miles to the entrance to Breton Sound between Grand Gosier Islands and Breton Islands; 36 feet deep across Breton Sound northwest for 20.3 miles where it enters a landcut; 36 feet deep through the landcut for 32.2 miles where it joins the Gulf Intracoastal Waterway at Mile 13.6E; and then through the waterway for about 5 miles to a turning basin at its junction with the Inner Harbor Navigation Canal at New Orleans. The approach to the landcut is protected by stone retention dikes on both sides of the channel and is well marked with aids.

The navigation of vessels in the Mississippi River, the Inner Harbor Navigation Canal to its junction with the Mississippi River-Gulf Outlet Canal, and the Mississippi River-Gulf Outlet Canal are under the jurisdiction of the U.S. Coast Guard. The Inner Harbor Navigation Canal provides a 5.8-mile deepwater connection between the Mississippi River and Lake Pontchartrain, the northern boundary of the city of New Orleans. The canal is owned by the State of Louisiana, and the portion between Lake Pontchartrain and the junction with the Intracoastal Waterway is operated by the Board of Commissioners of the Port of New Orleans. The portion of this canal between the Intracoastal Waterway and the Mississippi River is operated by the U.S. Army Corps of Engineers.

The Inner Harbor Navigation Canal bends to the left approximately 28 degrees at a point 3,000 feet above the Florida Avenue Bridge. Curving off to the right from this bend is the route of the Gulf Intracoastal Waterway coinciding with the Mississippi River-Gulf Outlet. The route of the Intracoastal Waterway eliminates the hazards of navigating the open water of Lake Pontchartrain during storms and the inconvenience and dangers of passing through five additional bridges on the inner Harbor Navigation Canal. The Mississippi River-Gulf Outlet offers a 500-foot by 36-foot channel for a distance of 75 miles from the Inner Harbor Navigation Canal to the 38-foot contour in the Gulf of Mexico.

Pilotage is compulsory at the bar and on the river for all foreign vessels over 100 tons and U.S. vessels over 1,000 tons under register in foreign trade. Pilotage is optional for coastwise vessels that have on board a pilot licensed by the Federal Government. There are four organizations that provide pilot services for the river area: the Associated Branch Pilots from the sea to Pilottown or Light 78; the Crescent River Port Pilots for the river between Pilottown or Light 78 and New Orleans; the New Orleans-Baton Rouge Steamship Pilots for the river between New Orleans and Baton Rouge; and the Associated Federal Coast Pilots of Louisiana, Inc. for public vessels and vessels in the coastwise trade from South and Southwest Passes to Baton Rouge. Pilottown, a small village on the east side of the river 2 miles AHP, is the exchange point for bar pilots and river pilots for both inbound and outbound vessels.

On the Mississippi River-Gulf Outlet Canal, the Associated Branch Pilots take vessels from the entrance to Pilottown or Light 78, about 28 miles above the entrance, where they are relieved by the Crescent River Port Pilots, who take vessels on to New Orleans. Pilots for South Pass and Southwest Pass board vessels in areas up to 3 miles off the sea buoys at the passes, depending on the weather. Pilots for the Mississippi River-Gulf Outlet Canal board vessels in the vicinity of Mississippi River-Gulf Outlet Approach Lighted Horn Buoy NO. The Associated Branch Pilots have a pilot station at the Southwest Pass off the West Jetty about 2 miles inside the entrance. They also have a pilot station at South Pass at a small settlement on the west side about 0.5 mile above the ends of the jetties. Both pilot stations are equipped to handle radio traffic on the same working channel as the pilot boats and they have radiotelephone communication with the pilot office in New Orleans.

The Associated Branch Pilots have prescribed a recommended draft limit of 15 feet and/or a deadweight tonnage limit of 21,000 d.w.t. for vessels using the South Pass. The deadweight tonnage limit is recommended because ships of large tonnage do not steer well. The Southwest Pass has a recommended draft limit of 45 feet, but no deadweight tonnage limit. When approaching the entrance to South Pass, vessels should not close the passes before the pilot boards.

The Crescent River Port Pilots have an office in New Orleans that is manned 24 hours a day year round. The river pilots board vessels off Pilottown, about 2.3 miles above Head of Passes Light. The pilot station, on the east side of the river at Pilottown, maintains a lookout and is equipped to handle radio traffic. The Crescent River pilots take vessels from Pilottown upriver to New Orleans and from Light 78 on the Mississippi River-Gulf Outlet Canal to New Orleans. On the canal, pilots board vessels from a private launch at Light 78. The river pilots boarding vessels at Pilottown rarely have information from the vessel's agent pertaining to the vessel's destination or working schedule while in port. Vessel masters are advised to contact their agent through the New Orleans Marine Operator to obtain information on the vessel's exact destination and estimated time of arrival. All Crescent River Port Pilots carry portable radiotelephones for bridge-to-bridge communications with other vessels on the river and canal.

The New Orleans-Baton Rouge Steamship Pilots board vessels from commercial launches that are continuing upriver. The pilots usually board vessels off The Point. The launch station is at Arabi on the east side of the river about 1.6 miles below the Inner Harbor Navigation (Industrial) Canal. All the upriver pilots carry portable radiotelephones and communicate with other vessels on the river. The pilots request a 3-hour advance notice of time of sailing for all downriver bound vessels departing berths above 126 miles AHP. The Associated Federal Coast Pilots of Louisiana provide service for public vessels and vessels in the coastwise trade from South and Southwest Passes to Baton Rouge. The pilots meet vessels at Southwest Pass Entrance Lighted Buoy SW. Vessels to be boarded are requested to maintain a slow speed.

There are thirty anchorage grounds designated for deep-draft navigation on the Mississippi River from Baton rouge through South and Southwest Passes, situated at various locations between mile 1.5 through mile 230.6 of the river. There are also four temporary or non-permanent anchorages that have been established by the Coast Guard District Commander to provide additional anchorage space as recommended by the Captain of the Port. In addition, there is a 4,000-foot quarantine anchorage on the west side of the river at New Orleans, about 2.3 miles east of the Inner Harbor Navigation Canal. At New Orleans, general and quarantine anchorages are on the west side of the river. Vessels may also take anchorage as directed by the Coast Guard District Commander. Anchorages at Baton Rouge are located on the west side of the river and in mid-river. Temporary anchorages may be prescribed by the Commander.

In the South and Southwest Passes, the tide generally has one high and one low water in 24 hours, the diurnal range varying from 0.9 to 1.4 feet. At New Orleans the range of tide during low-river stages averages about 0.8 foot. There is no periodic tide at high-river stages. Currents off the passes are variable in direction and velocity depending to a great extend upon the velocity and direction of the wind. Near the entrance to the passes, the currents depend upon the stage of the river. At the Southwest Pass entrance, the current is due chiefly to the discharge of the river. In general it sets southwest and its velocity varies from 0 to 4 knots, the average being about 1.7 knots. At times, however, there has been a southeast current of nearly a knot reported at this location.

The current in the river due to the tide is not strong at any point, and for purposes of navigation it is rarely taken into account. The average date of high-river stage occurs in April and of low-river stage in October. At Baton Rouge, the extreme difference between high and low stages of the river is 40 feet and the mean difference is about 21 feet. At New Orleans, the extreme difference between high and low stages is 17 feet and the mean difference is about 8 feet. Currents are based on high water flow of 1,100,000 cubic feet per second (cfs), medium water flow of 520,000 cfs, and low water flow of 180,000 cfs. The currents for Baton Rouge are 3.8 mph (3.3 knots) high water stage; 2.6 mph (2.3 knots) medium water stage; and 1.3 mph (1.1 knots) low water stage. The currents for New Orleans are 4.0 mph (3.5 knots) high water stage; 2.8 mph (2.4 knots) medium water stage; and 1.4 mph (1.2 knots) low water stage.

At several places in the lower part of the river, countercurrents or eddies often are found near the banks and, if taken advantage of, can greatly assist vessels bound up the river. Strong currents and powerful shifting eddies in the vicinity of Algiers Point will be encountered during high stages of the river. These conditions may make hazardous the operation of a tow which could normally be handled with ease. When the stage of the river is 10 feet or above on the Carrollton Gage, all underpowered vessels should be assisted by a tug in the vicinity and should not leave the harbor unless they can clear Algiers Point during daylight. Special precautionary measures are also advised for vessels operating in the harbor area controlled by the New Orleans Harbor traffic lights. In addition, terminal operators and fleet owners should observe extra precaution in the mooring of barges to prevent the possible breaking loose of such craft to the danger of all installations downstream.

Vessels navigating the Mississippi River at flood stages, when passing habitations or other structures, partially or wholly submerged and subject to damage from wave action, shall proceed slowly and keep as far away from such structures as circumstances permit, and shall also proceed slowly when passing close to levees. Under these conditions when transiting between Baton Rouge and The Jump (an opening on the right bank at Venice providing access to the Gulf), mariners are directed to steer a course as close as possible to the center of the river and to proceed at a speed sufficiently slow so that levees and revetments will not be endangered by wave wash. The mariner’s careful observation of the effects of the vessel’s wash is a vital element in this control.

In navigating the Mississippi River, it is understood that a ship must maintain sufficient headway at all times in order for the vessel to be controlled. As a large ship moves in the Mississippi River-Gulf Outlet Canal waterway, a wave is pushed ahead. As it comes abreast of a given point, a suction effect is created that abruptly drops the water level in the channel and the water is drawn off the banks of the waterway. The violence of the reaction depends on the speed and draft of the ship. As the ship passes, the displaced water rushes back toward the banks and could possibly capsize or throw a small boat onto the bank. Shortly after the ship has passed, waves cause severe agitation along the banks.

B.1.2 PORT OF NEW ORLEANS

The Port of New Orleans, located on both sides of the Mississippi River in the southeastern part of the State of Louisiana, is one of the largest ports in the United States. Its lower limit is about 80.6 miles AHP and its upper limit is about 115 miles AHP. The limits of the port encompass the parish of Orleans and the river frontage of the parishes of St. Bernard and Jefferson, including the city of New Orleans and other towns and communities on the north side (left bank) and south side (right bank) of the river. The development, operation, and control of the port is regulated by the Board of Commissioners of the Port of New Orleans.

The city of New Orleans is the major commercial area within the port limits. It is one of the largest cities on the Gulf and is a natural gateway to and from the entire Mississippi Valley with which it is connected by numerous inland water routes. The city proper is bounded on three sides by the Mississippi River. The city limits extend north to Lake Pontchartrain, which is connected to the river by the Inner Harbor Navigation Canal along the east side of the city. This canal connects the Mississippi River with Lake Pontchartrain, the Mississippi River-Gulf Outlet, and the Gulf Intracoastal Waterway east of New Orleans. Strong levees protect the city from flood waters of the Mississippi River, which at times rise to a level higher than that of the city streets.

The Port of New Orleans has more than 334 public and private wharves, piers, docks, and other facilities extending along 28 miles on both the left and right banks of the river. The public docks can handle as many as 85 ships at a time. The port mainly handles conventional and containerized general cargo, but is equipped to handle any type of cargo. The port is the heart of the busiest grain export area in the world. Other exports include machinery, oilseeds, animal feeds, metals, organic chemicals, metal ores and scrap, iron and steel products, and coal. The chief imports include crude petroleum, coffee, iron and steel products, ores and scrap, nonferrous metals, sugar, and crude rubber. About a third of the waterfront facilities are located within the parishes of St. Barnard, Orleans (City of New Orleans), and Jefferson. Most of the others are situated on the Harvey Canal, the Inner Harbor Navigation Canal, and the Algiers Canal; the few remaining ones are on other canals and tributaries in the river area. The Intracoastal Waterway above the Inner Harbor Navigation Canal and below Harvey Lock offers frontage for barges and small vessels.

Most of the wharves along the waterfront of the city of New Orleans are public facilities which are under the control of the Board of Commissioners (Dock Board) of the Port of New Orleans. Virtually all of these wharves parallel the river bank, and for about 10 miles along the bank there is an almost continuous quay. The depths at the wharves range from 6 to 42 feet, with depths about 35 feet alongside most wharves. The Dock Board has responsibility for maintaining sufficient depths alongside the wharves for ships to berth. The board controls the area from the faces of the wharves to 100 feet into the stream. The dock areas silt up rapidly and change from day to day. The Dock Board's dredge is working continually to keep the docks open.

Five companies own and operate diesel-powered tugs which are available for towing, docking, and undocking vessels along the lower Mississippi River. Four of the operators are based at the Port of New Orleans and one is based at port facilities located above New Orleans. The equipment consists of 48 tugs, more than 35 of which are involved in docking and undocking vessels in the lower river area; about 10 tugs are based at New Orleans. Tugs with ratings of about 2,400 horsepower are normally used for assisting in docking, undocking, towing in the harbor and canals, and towing to sea. Tugs of up to 4,600 horsepower are available if needed. Two tugs must be employed on all towing to and from the dry-docks, and should be employed on all ships towed around Algiers Point when the traffic lights are operating, and by large vessels going through the Inner Harbor Navigation Canal.

Several companies operate bunkering barges equipped with pumps for making deliveries of heavy bunker fuel, diesel fuel, lubricating oils, and gasoline to vessels at berth and to towboats in midstream. These barges have cargo-carrying capacities ranging up to 40,000 barrels and all are based in New Orleans. There are also three barges available for delivering fresh water to vessels in the port area. More than 30 separate areas along the Mississippi River are used for fleeting barges by a variety of companies, mainly in connection with the grain industry. All of these fleeting areas are located on the river between Baton Rouge and New Orleans. A number of the companies also have facilities for repair, cleaning, and maintenance of barges, and some operators offer marine repair service to the public.

B.1.3 PORT OF BATON ROUGE

Baton Rouge is the capital of Louisiana located on the east side of the river 229.5 miles AHP. The Port of Baton Rouge is a river port of considerable importance. The port limits extend from Union, 168.2 miles AHP, to Point Menoir, 255 miles AHP. The Greater Baton Rouge Port Commission owns and controls the public port facilities which include the Bulk Marine Terminal at Burnside, the grain elevator and general cargo terminal on the west side of the river at Port Allen, and the Port of Baton Rouge Terminal at the head of Baton Rouge Harbor on the east side of the river about 6.5 miles above Baton Rouge. Principal exports include wheat, corn, petroleum products, scrap iron, aluminum, lumber, steel products, rubber, and chemicals. Principal imports include sugar, coffee, iron, ores, sulfur, alcohol, and newsprint.

Tidal effects are felt in the river to some extent to 265 miles AHP, about 35.7 miles above Baton Rouge. The highest stage of the river ever recorded was 47 feet in 1927. Pilotage is compulsory on the river between Baton Rouge and the Gulf of Mexico. Tugs with ratings of up to 4,000 horsepower are available at the port to assist during docking. The Greater Baton Rouge Port Commission establishes the rules and regulations for the port. The Executive Director of the commission is the Port Director who is in charge of the management and operation of the port facilities under control of the commission. The Port of Baton Rouge has more than 70 piers and wharves located on both sides of the river and in the harbor. More than half of these facilities are for barges with depths of less than 15 feet alongside.

B.1.4 PLAQUEMINE

Ports located on both banks of the Mississippi River from the Gulf of Mexico through Southwest Pass to the lower limit of the Port of New Orleans, at approximately mile 81 AHP, are all within Plaquemine Parish below New Orleans. Pointe a la Hache, 49 miles AHP and about 46 miles below New Orleans, is the seat of Plaquemine Parish which embraces most of the lower Mississippi River. An oil transfer wharf operated by the Texas Pipeline Co. is at Davant on the north side of the River about 51.8 miles AHP. At Bellevue on the north side of the river about 55.2 miles AHP, Electro-Coal Transfer Corp. operates two bulk-material handling wharves. The lower wharf has 1,164 feet of berthing space with dolphins, 55 to 70 feet in depth alongside, and a deck height of 15 feet. Four unloading towers with a combined capacity of 4,200 tons per hour can transfer bulk materials directly from oceangoing vessels to river barges berthed at the rear of the dock face. The upper wharf has 1,880 feet of berthing space and depths of 55 to 70 feet. Principal commodities handled are coal and petroleum coke.

A grain elevator and wharf operated by Mississippi River Grain Elevator, Inc. is on the south side of the river 61.8 miles AHP. The wharf has a 536-foot face and 40 feet in depth alongside. Three gantry ship loaders have a combined loading rate of 50,000 bushels per hour. An offshore barge wharf and an offshore oil transfer tanker wharf operated by Gulf Oil Co. are at Alliance on the south side of the river at 62.5 and 63 miles AHP. The oil transfer tanker wharf with mooring dolphins allows 1,085 feet of berthing space with depths of 60 feet. Transfer barges berth on the backside of the tanker wharf. On the west side of the river 71.7 miles AHP, Dockside Elevators, Inc. operates two floating grain elevators used to transfer grain from river barges to oceangoing vessels. The vessels anchor in the river in depths of 80 feet with the grain elevators moored alongside. Cranes on the elevators transfer the grain from barges moored on the opposite side of the vessel at a rate of 300 to 500 tons per hour.

Braithwaite, on the south side of the river about 79.7 miles AHP just above English Turn Bend, has a large shipyard with an 800-ton floating dry-dock that specializes in the construction of medium to large barges and the repair of commercial vessels. Meraux, on the north side of the river about 87.5 miles AHP, has an oil refinery with facilities for receipt and shipment of crude oil and petroleum products by tanker and barge. Chalmette, on the north side of the river about 88.9 miles AHP, has several large oil refineries and an aluminum plant. Several wharves between mile 88.3 and 89.1 AHP are used for the receipt and shipment of petroleum products and for bunkering vessels.

Arabi, a suburb of New Orleans, is on the north side of the river just west of Chalmette. A deep-draft wharf and a smaller one are at a large sugar refinery; one wharf is used by ship service boats and the other by the refinery company. Just west of the sugar refinery wharf, at the ship service boat wharf, is the landing for the pilot boats. On the south side of the river opposite Chalmette and Arabi at Algiers, there are barge moorings, towing company wharves, the large floating dry-docks of a large ship repair firm, the U.S. Naval Station, and other towing company wharves and barge moorings.

The Port of Plaquemine, is located on the west side of the river about 208.8 miles AHP, at the junction of the Mississippi River and Bayou Plaquemine. A vehicular ferry crosses the river just below Plaquemine. The town is a foundry, and several sugarmills are in the vicinity. A petrochemical wharf is operated by Hercofina on the west side 204.9 miles AHP. The wharf has 700 feet of berthing space with dolphins and 60-foot depths reported.

B.1.5 PORT OF SOUTH LOUISIANA

The Parish of St. Charles, called the Port of South Louisiana, encompasses port facilities above New Orleans and below Baton Rouge. A total of seven waterfront grain elevators with a total storage capacity of more than 33 million bushels serve the tri-parish port area, consisting of St. James, St. John The Baptist, and St. Charles, above New Orleans. These facilities primarily handle the export shipment of grain received by barge and rail. Each elevator is supported by extensive barge fleeting and servicing areas, and by adjoining rail car storage facilities.

The St. Charles grain elevator, situated on the left bank at 120.6 miles AHP, has berthing space for 1,000-foot vessels with 40-foot depths alongside. The facility has storage for 5 million bushels of grain and can load vessels at a rate of 60,000 bushels per hour. The grain gallery extends 500 feet along the wharf with seven vessel-loading spouts, and is equipped with two 42-inch belt conveyors extending from the grain elevator in the rear. A fleeting area with shore moorings for 12 barges is located at the lower end of the barge slip.

APPENDIX B.2

DETAILED PORT INFORMATION ON THE

CONSOLIDATED PORT OF NEW YORK AND

PORTS ON THE HUDSON RIVER INCLUDING ALBANY, NY

B.2.1 GENERAL

The Port of New York and New Jersey Harbor are 386 nautical miles southwest by water from Boston Harbor, and 240 nautical miles northeast of Philadelphia. The New York-New Jersey Port District encompasses the ports of both states, with a total of 1,500 square miles within a 25-mile radius of the Statue of Liberty. The area includes 17 counties and 234 municipalities, with a population of more than 12 million. Eight separate bays and associated waterways provide 755 miles of frontage of which 460 miles is in New York and 295 miles is in New Jersey.

The bi-state port has a large, protected, natural deep-water harbor that is situated in close proximity (only 9 miles) from the Atlantic Ocean. The port district covers these areas contiguous to New York Harbor and its approaches: Jamaica Bay to the Queens-Nassau County Line, and Long Island Sound to the Connecticut border on the east; the Hudson River to Tarrytown on the north; Newark Bay and Authur Kill, including navigable portions of the Hackensack, Passaic, and Raritan Rivers on the west; and Raritan and Sandy Hook on the south.

New York Harbor is the principal entrance by water to New York City and the surrounding ports. The harbor is divided by The Narrows into Lower Bay (Outer Harbor) and Upper Bay (Inner Harbor). The Battery, the southern tip of Manhattan, is at the junction of East River and Hudson River. The main channel from the sea to the deepwater terminals in Hudson River has a depth of 45 feet. A traffic separation scheme has been established in the approaches to New York Harbor from the sea. The pilot boats maintain station in the triangle-shaped cruising area west of Ambrose Light. Ambrose Light marks the entrance to Ambrose Channel which is the principal deepwater passage through the Lower Bay.

The Lower Bay is that part of New York Harbor extending from Sandy Hook westward to the Raritan River and northward to The Narrows and eastward through Jamaica Bay. The Lower Bay extends about 9 miles from The Narrows to the Atlantic Ocean. The main channels serving the Lower Bay are Ambrose, Sandy Hook, and Chapel Hill. Ambrose Channel is the principal entrance to New York Harbor and extends from the sea to deep water in the Lower Bay. The Anchorage Channel is an extension of Ambrose Channel and leads through the Upper Bay to The Battery. The Hudson River Channel continues northward from The Battery for about 5 miles to West 59^{th} Street, Manhattan. The depth of these channels is 45 feet.

The Sandy Hook Channel, 35 feet in depth, provides a secondary route from the sea to deep water in Lower Bay. It connects with Raritan Bay Channel to the west, Chapel Hill Channel (30 feet deep) to the north, and Terminal Channel to the south. These channels are well marked with navigational aids. Swash Channel provides a natural buoyed passage between Ambrose Channel and Sandy Hook Channel. Swash Channel has a controlling depth of 18 feet, but care is necessary to avoid spots with 13-foot depths near the sides of the channel. Sandy Hook Bay is the southern part of Lower Bay, west of Sandy Hook and east of Point Comfort. The bay is an excellent anchorage area, providing depths of water ranging from 30 feet just inside Sandy Hook to 15 feet near its southern part. The shoaling is gradual and the bottom is good holding ground.

Rockaway Inlet, the entrance into Jamaica Bay, is between Rockaway Point on the southeast side and Manhattan Beach and Barren Island on the north side. The inlet is obstructed by a shifting sand bar. The entrance channel has depths of 19 feet or more except for shoaling on the west side opposite the jetty light. A shoal with depths of less than 1 foot and marked by breakers is west of the entrance channel. Jamaica Bay is on the south shore of Long Island about 15 miles southeastward of The Battery. The commercial traffic in Jamaica Bay consists of motor tankers, barges and tugs; the bay is used extensively by pleasure craft.

The Upper Bay is that portion of New York Harbor between The Narrows and The Battery and consists of the Lower Hudson River, East River, Long Island Sound, and the tributary waterways. The Upper Bay is connected with the Lower Bay by The Narrows, a natural channel having a width of about 3,500 feet and depths varying from 45 to 100 feet. Anchorage Channel is the main passage through the middle of the bay. Bay Ridge Channel, Red Hook Channel, and Buttermilk Channel follow the Brooklyn piers from The Narrows to the East River. The depths in these channels are mostly 30 to 40 feet. Caution should be exercised when docking and undocking vessels along the southeasterly side of Bay Ridge Channel because the current may flow in a direction opposite to the normal channel flow, especially between the piers.

Upper Bay extends southward from the junction of the Hudson and East Rivers opposite The Battery. The Hudson River flows in a southerly direction and empties into Upper New York Bay. The East River is a tidal strait about 14 miles long and from 600 to 4,000 feet wide. It connects deep water at Governors Island in the Upper Bay with Long Island Sound. Long Island Sound is a deep navigable waterway situated between the shores of Connecticut and New York on the north, and the northern coast of Long Island on the south. Arthur Kill is a narrow body of water separating Staten Island, New York, from New Jersey. Newark Bay is a tidal estuary about 1 mile wide and 4 miles long, located north of Arthur Kill and west of Kill Van Kull. Bayonne and Jersey City are on the east side of the bay and Elizabeth and Newark are on the west side.

Vessel Traffic Service New York, operated by the U.S. Coast Guard, serves the New York Harbor. A Coast Guard station and a Captain of the Port office are at the Coast Guard Support Center on Governors Island.

The administration of the Port of New York and New Jersey and the enforcement of its laws are divided among various departments of the Federal, State, and Municipal Governments. The Coast Guard has established a speed control policy for all types of vessels operating in the confined waters of the New York-New Jersey area. Masters and pilots are strictly prohibited from operating any vessel at an excessive speed which endangers life, limb, or property, including damage to vessels moored at docks and terminals.

Pilotage in New York Harbor and its approaches is compulsory for foreign vessels and U.S. vessels under register entering or departing from the Port of New York and New Jersey. Pilotage is optional for enrolled vessels having on board a pilot licensed by the Federal Government. Vessel arrivals are reported to the Maritime Exchange in New York by the pilots. Pilotage service for vessels entering the port through Lower Bay is available from the United New York-New Jersey-Sandy Hook Pilot Association. The pilot cruising and boarding area is located west of Ambrose Light. Pilotage service for vessels entering the port from Long Island Sound is also provided by the Sandy Hook Pilot Association. The pilot boat boarding area for these pilots is off Execution Rocks. The pilot station is located on a pier on the east side of City Island about 0.4 mile north of Belden Point and the pilot boat ties up at the pier. Masters of vessels entering the Port of New York and New Jersey are requested at the time of boarding to proceed at a speed not exceeding 3 to 4 knots. Pilotage for U.S. enrolled vessels in the coastwise trade is available from Interport Pilots Agency, Inc.

General, explosives, naval, and special anchorages have been prescribed for the Port of New York by Federal Regulations. Designated anchorage areas are established in Long Island Sound, the East River, the Hudson River, Upper Bay, Sheepshead Bay, Jamaica Bay, Randall Bay, Lower Bay, Newark Bay, and Arthur Kill. The maximum speed is 6 knots within any designated anchorage area.

The mean range of tide in New York Harbor is 4.7 feet at Sandy Hook and 4.6 feet at The Battery. Daily predictions for both places are provided in the Tide Tables. The flood current entering Lower Bay from the sea attains a velocity of about 2 knots in the Ambrose Channel entrance, near the outer extremities of Sandy Hook, Coney Island, and The Narrows. It sets generally parallel to the lower straight section of Ambrose Channel and tends to continue in the direction to where the channel bends toward The Narrows, setting more or less diagonally across the upper straight section of Ambrose Channel. At the beginning of the flood, the current sets in at the bottom and near the shores while it is still ebbing at the surface in Ambrose Channel. The ebb in Lower Bay is generally stronger than the flood by 10 percent or more. At its strength it sets from The Narrows approximately parallel to the upper straight end of the lower straight section.

In the Upper Bay channel area north of Governors Island, cross currents may be encountered. At such times, large vessels must take special care in navigating the channel. It is reported that the most dangerous time is about 2 hours after high water at The Battery. At the seaward end of Ambrose Channel, the velocity of the flood current is 1.7 knots and of the ebb current 2.3 knots. In The Narrows the velocity of the flood current is about 1.7 knots and 2 knots of the ebb. In the entrance to Hudson River the velocity of the flood and ebb currents is 1.4 knots. Off Grants Tomb, the flood and ebb strengths are 1.6 and 1.9 knots, respectively.

The New York City Department of Ports and Terminals administers the piers along the New York waterfront within the city limits. The Port Authority of New York and New Jersey is an executive body appointed by the Governors of New York and New Jersey. The Authority's Port Department serves as a bi-state port development, operations, maintenance, and promotion organization. The Port Authority administers piers in Manhattan, Brooklyn, Hoboken, Port Newark, and Port Elizabeth.

The port has more than 1,100 waterfront facilities, most of which are privately owned and operated, and the rest are owned or operated by the Port Authority, federal, state, or other municipalities. Containership terminals are throughout the port, but principally at Elizabeth, Newark, Jersey City, and Weehawken, New Jersey. Other containership facilities are at Howland Hood, Staten Island, and Brooklyn. Break-bulk general cargo terminals are throughout the port but principally along the east side of Upper New York Bay, on the East River, and at Port Newark. Petroleum and other liquid cargo facilities are along Arthur Kill, on the Passaic and Hackensack Rivers, and along Newtown Creek, Brooklyn. The wharves and piers of New York City along the waterfronts of the Hudson and East Rivers are numbered beginning at The Battery and follow in sequence eastward along the East River and northward along the Hudson River.

All types of floating equipment is available to meet the shipping needs of the Port of New York and New Jersey. This equipment consists of tugs and towboats, barges, scows, lighters and car floats, tank barges and tankers, and other specialized types of harbor craft. Services of most of the operating companies extend beyond the limits of the port to points along the Atlantic coast line, Long Island Sound, the Hudson River, the New York State Barge Canal, and the Great Lakes. Several of the companies operate tugs equipped for ocean towing. Horsepower ratings for in-use tugs range from 1,700 to 6,500. Bunkering barge capacities range from 2,150 to 80,000 barrels. A number of the bunkering barges are self-propelled and their horsepower ratings range from 400 to 3,600.

B.2.2 PORT OF ALBANY

The Hudson River rises in the Adirondack Mountains and flows 315 miles in a southerly direction into New York Bay. At Waterford, about 2.5 miles about the Federal lock and dam at Troy, the river connects with the New York State Barge Canal system, which provides channels to the Great Lakes Port of Oswego, New York, and to improved waters in Canada leading to the St. Lawrence River. The Port of Albany, New York, is on the right bank of the Hudson River about 143 statute miles north of The Battery. The port is the terminus of the deep-draft Hudson River and is the principal port above New York City.

From the Atlantic Ocean to the mouth of the river, vessels pass through Ambrose and Anchorage Channels located in the Lower and Upper Bays, respectively. The Albany Port District, as established by the laws of the State of New York, encompasses a portion of the Albany and Rensselaer waterfronts. The principal waterborne commodities handled at the port consist of general cargo, grain, molasses, and scrap metal. Waterborne commerce handled at facilities on the river outside of the port consist of petroleum products, cement, gypsum, crushed rock, sand, and gravel.

There are four established anchorages in Hudson River: at Nyack, at West Point, at Hyde Park, and at Coeymans. The restricted width of the Hudson River at Albany is not sufficient to permit vessels to swing at anchor without interfering with passing vessels. However, in an emergency, vessels sometimes anchor in midstream to await berthing space. Vessels proceeding from New York to Albany frequently anchor in the vicinity of Kingston, 46 miles below Albany, to await daylight hours for passing the narrower channel above Hudson. Anchorages for vessels are located at mile 119 above Hudson on the west edge of the channel, and at mile 127 just above Stuyvesant on the east edge of the channel. These anchorages have depths of 32 feet, widths of 400 feet, and an average length of 2,400 feet.

The tides in the Hudson River are affected by freshets, winds, and droughts. The mean range of tide is 4.5 feet at The Battery, 3.7 feet at Yonkers, 2.8 feet at Newburgh, 3.1 feet at Poughkeepsie, 3.7 feet at Kingston, 4.6 feet at Albany, and 4.7 feet at Troy. The currents in the Hudson River are influenced by the same variables that affect the tides. The times of slack water and the velocities and durations of flood and ebb are subject to extensive changes; the times of strength are less likely to be affected. The currents usually set fair with the channels except in the vicinities of bends and wharves. In the entrance to Hudson River, the velocity of the flood and ebb currents is 1.4 knots. Off Grants Tomb, the flood and ebb strengths are 1.6 and 1.9 knots, respectively. At Albany, the current velocity is 0.3 knot flood and 0.8 knot ebb. Near Troy Lock and Dam, the current does not flood and the ebb has a velocity of 0.7 knot.

There are 98 waterfront piers, wharves, and docks on the Hudson River. Eight of these facilities are within the Port of Albany, of which 7 are along the right bank of the river, in Albany, and one is on the left bank in the town of Rensselaer. Eighty facilities are located on the Hudson River above and below the Port of Albany, 52 on the right bank and 28 on the left bank. Additional facilities are located on Rondout Creek, Esopus Creek, and Catskill Creek.

The Turecamo Coastal & Harbor Towing Corporation has one towboat based at the Port of Albany. The *Francis Turecamo* is a diesel-powered towboat with 1,600 horsepower, a length of 84.8 feet, a beam of 24 feet, and a loaded draft of 9.8 feet. Other floating equipment, operating at the Port of Albany and on the Hudson River below the New York State Barge Canal System, is based at the Port of New York and in the canals above Albany.

B.2.3 PORT OF NEW LONDON

Long Island Sound is a deep navigable waterway lying between the shores of Connecticut and New York and the northern coast of Long Island. New London Harbor, near the east end of Long Island Sound at the mouth of the Thames River, is an important harbor of refuge where deep draft vessels can find anchorage in any weather and at all seasons. The harbor comprises the lower three miles of Thames River from Long Island Sound to the bridges, and includes Shaw Cove, Greens Harbor, and Winthrop Cove. Waterborne commerce at the port and on the Thames River consists chiefly of petroleum products, chemicals, lumber, pulpwood, and general cargo.

New London Harbor is approached through the main entrance channel extending from deep water in Long Island Sound to deep water in the upper harbor area. The harbor is generally used by vessels drawing 9 to 30 feet; the deepest draft entering is about 36 feet. Boulders and broken ground exist in the Long Island Sound region, but there is little or no natural change in the shoals, and the waters are well marked by navigational aids. Submarines may be operating submerged in the approaches to New London and the Connecticut River, and off the northern shore of Long Island, and vessels are advised to proceed with caution in those areas. In ordinary winters, the floating and pack ice in Long Island Sound impedes navigation but does not render it unsafe. In exceptionally severe winters, only powerful steamers can make their way.

Pilotage in Long Island Sound is compulsory for foreign vessels and U.S. vessels under register. Pilotage in these waters is available from, but not limited to, Sound Pilots, Inc. (a division of Northeast Marine Pilots, Inc.) located in Newport, Rhode Island; Connecticut State Pilots (a division of Interport Pilots Agency, Inc.) based in New London, Connecticut; Constitution State Pilots Association of New Haven, Connecticut; and Long Island Sound State Pilots Association also located in New Haven. The pilot boat sets radio guard at least one hour before a vessel's estimated time of arrival.

Pilotage for New London is available from the New London Connecticut Pilots Association; the pilot boards a ship about 2 miles south of New London Ledge Light. Pilot services are also available from Constitution State Pilots Association; the pilot will meet a New London bound vessel about 2 miles south of New London Ledge Light, and will also meet a vessel off Montauk Point. Pilotage for New London is also available from Long Island Sound State Pilots Association, Inc., and the pilot will meet a ship off Montauk Point among other locations. Sound Pilots, Inc. also provides pilot services, and these pilots meet a ship bound for a Long Island Sound port, off Point Judith, but will also meet a ship off Montauk Point by prearrangement.

The time of tide is nearly simultaneous throughout Long Island Sound, but the range of tide increases from about 2.5 feet at the east end to about 7.3 feet at the west end. The effect of strong winds, in combination with the regular tidal action, may at times cause the water to fall several feet below the plane of reference of the charts. The mean range of tide at New London is 2.6 feet. The tidal currents follow the general direction of the channel and usually are not strong. At Winthrop Point, on the west side of the river at New London, the velocity is 0.4 knot. At Stoddard Hill about 6.5 miles above New London, the velocity is 0.7 knot on the flood and 0.4 knot on the ebb. During freshets or when the Thames River is high and the wind is from the north, the current can have considerable southerly set even on the flood.

Tugs with ratings up to 3,200 horsepower are available at New London. Vessels usually proceed to the upper harbor without assistance, although a tug may be required when entering with a head wind and contrary current. Large vessels normally require tugs for docking and undocking. The harbor has more than 30 wharves and piers, most of which are used as repair berths, and for mooring recreational craft, fishing vessels, barges, ferries, and government vessels. Depths alongside these facilities range from 10 to 40 feet.

APPENDIX B.3

DETAILED PORT INFORMATION ON THE PORTS ON THE DELAWARE RIVER INCLUDING PHILADELPHIA, PA

B.3..1 GENERAL

The Delaware Bay and the Delaware River form the boundary between the State of New Jersey on the east and the States of Delaware and Pennsylvania on the west. The Delaware Bay is an expansion of the lower part of the Delaware River, with an arbitrary dividing line 42 nautical miles above the Delaware Capes, extending from Liston Point, Delaware, to Hope Creek, New Jersey. Delaware Capes is the entrance to the Delaware Bay from the Atlantic Ocean. The entrance is about 10 nautical miles wide between Cape May, an extensive peninsula on the northeast side of the entrance, and Cape Henlopen on the southwest side. Delaware Capes refers to a line from Cape May Light to the tip of Cape Henlopen; this designates the breakwater which is 70 nautical miles from Marcus Hook.

The Delaware Bay and the Delaware River represent the principal artery for waterborne commerce, not only for Philadelphia and points on the left bank opposite that city, but also for other localities beyond the limits of the Philadelphia Harbor, including Wilmington, Delaware; Chester and Marcus Hook, Pennsylvania; and Trenton and Salem, New Jersey. Deep draft vessels use the Atlantic Ocean entrance while vessels with drafts of less than 33 feet can enter the Delaware River from the Chesapeake Bay through the Chesapeake and Delaware Canal. This canal provides an alternate protected waterway connecting the Delaware River and Chesapeake Bay ports.

A visual reporting station and radio control point for the Philadelphia Maritime Exchange is located about 0.5 mile southward from the tip of Cape Henlopen. A traffic separation scheme, designed to aid in the prevention of collisions at the approaches to major harbors, has been established off the entrance to Delaware Bay. The scheme consists of directed traffic areas each with one-way inbound and outbound traffic lanes separated by defined separation zones, a precautionary area, and a pilot boarding area. The scheme is recommended for use by all vessels approaching or departing Delaware Bay, but it is not necessarily intended for tugs, tows, or other small vessels which traditionally operate outside of the primary traffic lanes or close inshore.

The precautionary area for the Delaware Bay entrance is inscribed by part of a circle with a radius of 8 miles centered on Harbor of Refuge Light and extending from off Cape May Point to the shore south of Cape Henlopen with the traffic lanes fanning out from the circumference of the circle. The outer part of the northeast quadrant of the area is full of shoals, and there are shoal spots covered from 28 to 30 feet in the western extension.

The usable part of the precautionary area has depths of 30 to more than 100 feet. Several wrecks and obstructions are located about 1 to 1.7 miles east and southeast of Harbor of Refuge Light. The precautionary area is used by both incoming and outgoing vessels making the transition between Delaware Bay and the traffic lanes, and extreme care is advised in navigating within this area. The current velocity is 1.8 knots in the Delaware Bay entrance.

The Delaware Bay is shallow along its northeastern and southwestern sides, with extensive shoal areas close to the main channel. The bay has natural depths of 50 feet or more for a distance of 5 miles above the Delaware Capes, and depths of 40 feet from that point to the upper end of Newbold Island 110 miles above the Capes. The New Jersey side of Delaware Bay is low, with few prominent marks. The principal tributaries are Maurice and Cohansey Rivers, which can be used as harbors of refuge by small boats going between Cape May Canal and the Chesapeake and Delaware Canal. General depths along this side of the bay are 7 to 15 feet, but there are many spots with depths of less than 6 feet. The shoals generally are not marked, and local navigational knowledge is needed to avoid them. The channels have strong currents, and many tide rips form near Prissy Wicks Shoal.

Pilotage on the Delaware Bay and River is compulsory for all foreign vessels and U.S. vessels under register in foreign trade. Pilotage is optional for U.S. vessels involved in the coastwise trade that have on board a pilot licensed by the Federal Government for these waters. Pilot services are provided on a 24-hour basis by the Pilots' Association for the Bay and River Delaware, the Chesapeake and Interstate Pilots Association (Federal Pilots), and the Interport Pilots Agency, Inc. (Federal Pilots). The Pilots' Association for the Bay and River Delaware maintains a pilot station at Cape Henlopen and an office in Philadelphia. Pilots are generally arranged for in advance through ships' agents and board incoming vessels from the pilot boat in the pilot boarding area off Cape Henlopen. The Pilots' Association also provides qualified offshore "advisors" for the deepest draft vessels.

The Ports of Philadelphia Maritime Exchange, in cooperation with the Pilots Association for the Bay and River Delaware, has established a communication and information system for vessels operating in the Delaware Bay and rivers. The lower bay area is monitored by "Cape Henlopen Tower" and the upper bay and rivers are handled by the Ports of Philadelphia Maritime Exchange. All vessels are requested to convey information to the Ports of Philadelphia Maritime Exchange related to position, estimated time of arrival, docking instructions, and arriving/departing piers or anchorages in the upper bay and river.

The Coast Guard Captain of the Port of Philadelphia and the Mariner's Advisory Committee for the Bay and River Delaware jointly recommend precautionary measures that should be taken while transiting in the Delaware Bay and rivers. These navigational guidelines stipulate that vessels transiting above the Chesapeake and Delaware Canal shall have a manned anchor detail; for vessels calling at Marcus Hook, whether to anchor or dock, tugs should be alongside and made fast between the designated buoys on the Bellevue Range; diesel vessels should change to a lighter fuel for maneuvering purposes prior to arrival at the upper end of Liston Range; and vessels must establish that both steering engines and all main generators are operational during the master/pilot exchange of information.

There are 16 federally designated anchorages established in the Delaware Bay and the Delaware River. The anchorage areas mostly have sand bottoms and offer good holding ground in depths ranging from 31 feet to more than 100 feet. Deep-draft vessels sometimes anchor in various places along the dredged channel through the lower bay, but usually these vessels continue to more sheltered areas in the upper bay and river. One anchorage in the Delaware Bay, southwest of the Brandywine Channel, is specifically designated for deep-draft tankers to anchor and lighter (off-load by means of a barge used for conveyance of cargo from ship to shore) their cargo before proceeding up the Delaware River. More than 190 piers, wharves, and docks are available along the waterfront areas to handle petroleum products, miscellaneous bulk commodities, and a variety of dry bulk materials and liquid commodities.

Floating equipment is based at several locations along the Delaware River and includes 35 tugs and towboats with ratings up to 11,120 horsepower which are used for towing, docking, undocking, and shifting vessels. Most of the tugboat companies will dispatch their vessels to any place in Delaware Bay or its tributaries. Some of the companies also have tugs available for deep-sea towing. Tank barges with cargo-carrying capacities ranging up to 417,000 barrels are used for lightering crude oil tankers and for making deliveries of bunker fuel to vessels at berth and at anchor. Most large vessels are bunkered from barges alongside.

B.3.2 CHESAPEAKE-DELAWARE CANAL

The Chesapeake and Delaware Canal is a sea-level waterway that extends from the Delaware River at Reedy Point below Delaware City to Back Creek at Chesapeake City, then down to Elk River, an arm of the Upper Chesapeake Bay. The Reedy Point entrance is 51 miles above the Delaware Capes, 35.5 miles below Philadelphia, 62 miles from Baltimore, and 187.5 miles from the Virginia Capes. Vessel speed in the inland waterway canal is strictly regulated, and no vessel may be raced or crowded alongside another vessel. Vessels of all types, including pleasure craft, are required to travel at a safe speed at all times throughout the canal and its approaches so as to avoid damage to wharves, landings, riprap protection, or other boats, or injury to persons. All vessels proceeding with the current shall have the right-of-way over those proceeding against the current. Vessels are not permitted to stop or anchor in the ship channel.

The Chesapeake and Delaware Canal is 35 feet deep and 400 feet wide. The mean range of tide is 5.5 feet at the Delaware River end of the canal and 2.7 feet at Chesapeake City. High and low waters in Delaware

River are about 2 hours later than in Elk River. The heights of high and low waters are greatly affected by the winds; northeast storms raise the level and westerly storms lower it. The current velocity is 2.6 knots on the flood and 2.1 knots on the ebb at the Reedy Point bridge, and about 2 knots at the Chesapeake City bridge. The flood sets eastward and the ebb westward. Storms may increase these velocities to 3.0 knots or more, and at such times tows usually have difficulty making headway against the current.

Pilotage through the canal from Delaware River to Chesapeake City is provided by the Pilots' Association for the Delaware Bay and River. Pilotage from Chesapeake City to Maryland ports and to Washington, D.C., is provided by the Association of Maryland Pilots. Both pilot associations maintain a common station on the north bank of the canal at Chesapeake City. When vessels proceed to Virginia ports, the Maryland pilots are replaced by pilots of the Virginia Pilots Association at a point off the mouth of the Severn River on the approach to Annapolis, Maryland.

The District Engineer, Corps of Engineers, has administrative supervision over the Chesapeake and Delaware Canal, and is responsible for the enforcement of all regulations, including rules governing the dimensions of vessels which may transit the waterway, and other special conditions and requirements which regulate the movement of vessels using the waterway. Vessel traffic through the canal is monitored by the Chesapeake City dispatcher. The maximum overall length of self-propelled vessels transiting the canal is 886 feet; the maximum overall length of tugs and tows which may transit the canal is 760 feet.

When transiting the canal, vessels up to 350 feet in length must have a minimum of one tug with at least 1,500 horsepower; vessels between 350 and 550 feet in length need a minimum of two tugs with at least 3,000 total horsepower; and vessels between 550 and 760 feet in length require a minimum of three tugs with at least 6,000 total horsepower. Integrated pusher-type towboats transiting the waterway are limited in maximum overall length and extreme breadth. No towboat is permitted to enter the canal with more than two loaded barges or three light barges.

B.3.3 PORT OF WILMINGTON

The Port of Wilmington is on the north side (right bank) of the Christina River 2.5 miles above the mouth at its junction with the Delaware River, approximately 62 nautical miles above the Delaware Capes. Both sides of the river at the city are lined with wharves which support an extensive traffic in barges. Deepwater facilities are on the south side of the river just inside the entrance. Vessels must not anchor in the Christina River channel within the city limits of Wilmington or tie up at any wharf more than two abreast without permission of the harbor commissioners. A general anchorage is established off Deepwater Point, south of the river entrance. The mean range of tide is 5.7 feet at Wilmington, and the current velocity is about 0.8 knot. Harbor regulations limit the speed of vessels in the Christina River to 8 miles per hour. At Carneys Point, across the Delaware River from the Christina River, the Corps of Engineers has requested that masters limit the speed of their vessel when passing wharves and piers so as to avoid damage by suction or wave wash to property or persons.

B.3.4 MARCUS HOOK

Marcus Hook is an important petroleum center where large quantities of crude oil are received and refined petroleum products are shipped. Vessels can be bunkered at the rate of 1,500 to 5,000 barrels per hour, and floating equipment companies also operate barges for bunkering in the waterways or alongside other wharves. A general anchorage with a preferential area for vessels awaiting quarantine inspection is located on the southeast side of the main ship channel opposite Marcus Hook. The mean range of tide is 5.6 feet at Marcus Hook; the current velocity is about 1.7 knots. Deep-draft wharves and piers are situated along the Delaware River and are equipped to handle petrochemicals and miscellaneous bulk material in addition to petroleum products.

B.3.5 PORT OF PHILADELPHIA

The Port of Philadelphia, one of the chief ports of the United States, is at the junction of the Delaware and Schuylkill Rivers, approximately 80 nautical miles above the Delaware Capes. The port comprises the navigable waters of the Delaware and Schuylkill Rivers which are bordering on the municipality. The municipal limits on the Delaware River extend from Fort Mifflin on the south to Poquessing Creek on the north, a distance of about 20 miles. Large quantities of general cargo including crude oil, refined petroleum products, sugar, ore, coal, and grain are handled at Philadelphia in both foreign and domestic trade. The port has more than 45 deep-water piers and wharves along the Delaware and Schuylkill Rivers.

In the Philadelphia-Trenton section of the river, masters are especially requested to limit the speed of their vessels when passing wharves and piers so as to avoid damage by suction or wave wash to property or persons. General and naval anchorages are designated at Philadelphia. The mean range of tide is about 5.9 feet at Philadelphia and 6.8 feet at Trenton. The mean tidal range is about 5.7 feet in Schuylkill River, and current velocity is about 0.5 knot in the entrance. A large fleet of tugs up to 3,300 horsepower is available at Philadelphia, day or night, for any type service required. As a general rule, tugs are not required for vessels moving between Philadelphia and the ocean; most vessels traverse this distance under their own power.

B.3.6 THE PORT OF CAMDEN

The Port of Camden is directly opposite Philadelphia on the New Jersey bank of the Delaware River, and represents an important manufacturing center. The South Jersey Port Corporation, with headquarters at Camden, has jurisdiction over the New Jersey ports bordering the Delaware River and Bay from Trenton to the Atlantic Ocean. The Camden city waterfront extends about 3.4 miles from Newton Creek to Cooper River, and includes the petroleum terminals at Pettys Island and Fisher Point Dike.

APPENDIX B.4

DETAILED PORT INFORMATION ON THE PORTS OF THE PUGET SOUND INCLUDING SEATTLE, WA

B.4.1 GENERAL

The entrance of the Strait of Juan de Fuca is 683 nautical miles north of San Francisco, California, and is considered the breakwater for this study. This strait is the connecting channel between the Pacific Ocean and Admiralty Inlet extending southward to Puget Sound, and to passages extending northward to the inland waters of British Columbia and southeastern Alaska. The strait separates the southern shore of Vancouver Island, Canada, and the northern Coast of the State of Washington. From the ocean and through the strait, and Admiralty Inlet into Puget Sound, the waters are wide and deep.

Puget Sound extends about 90 miles south from the strait to Olympia. Throughout the length of Puget Sound, there are numerous channels around islands and inlets branching from it in all directions, particularly near its southern end. Deep-draft traffic is considerable in the larger passages, and small craft operate throughout the area which is characterized by unusually deep water and strong currents. Navigation in this area is comparatively easy in clear weather, and the outlying dangers are few and marked by aids. The currents follow the general direction of the channels and have considerable velocity. Due to heavy vessel concentrations, the Strait of Juan de Fuca, the San Juan Islands, the Strait of Georgia, and Puget Sound, and all adjacent waters, are a regulated navigation area. To enhance vessel traffic safety during periods of congestion, the Coast Guard may establish temporary special traffic lanes.

Pilotage in the Puget Sound area is compulsory for all vessels except those under enrollment or engaged exclusively in the coasting trade on the West Coast of the continental United States and/or British Columbia. Pilotage is provided by the Puget Sound Pilots. The pilots are picked up at Port Angeles Harbor, 62 nautical miles from the breakwater. The Marine Exchange of Puget Sound, located in Seattle, has a vessel monitoring and reporting service which tracks the arrival of a vessel from a time prior to arrival at the pilot station to a berth at one of the Puget Sound ports. Constant updates of the ship's position and estimated time of arrival are maintained through a variety of sources. This information is available to and is passed on to the vessel's agents and other interested parties. This reporting process continues until the vessel passes the pilot station on the outbound voyage. Other provisions offered by the Marine Exchange include a daily newsletter about future marine traffic in the Puget Sound area, communications services, and a variety of coordinative and statistical information.

B.4.2 PORT OF SEATTLE

The Port of Seattle is located in Puget Sound, 124 nautical miles from the ocean entrance of the Strait of Juan de Fuca, and represents one of the largest container ports in the United States. The port consists of an outer harbor and an inner harbor. The outer tidal, salt water portion of the port includes Elliott Bay; an indentation on the east side of Puget Sound; the East, West, and Duwamish Waterways; Shilshole Bay; and the portions of Puget Sound adjacent to Ballard on the north, and West Seattle to the south of the entrance of Elliott Bay. The main harbor is in Elliott Bay between Magnolia Bluff on the north and Duwamish Head on the south. The East and West Waterways are dredged channels at the south side of Elliott Bay. Harbor Island, consisting of filled land, is located between the East and West Waterways. Duwamish Waterway extends southward from the south end of the West Waterway for 5.12 miles to a turning basin at the upstream, upper end of the waterway.

Seattle's fresh water (non-tidal) inner harbor consists of Lake Union and Lake Washington, which are connected with each other and with Puget Sound by the Lake Washington Ship Canal. From deep water in Puget Sound to deep water in Lake Washington, the distance is about 8 miles. The "Hiram M. Chittenden" double navigation lock is located at the west end of the canal, between Shilshole Bay and Salmon Bay. A speed limit of 4 knots is enforced within the guide piers of the Chittenden Locks. Passage time is less than 30 minutes for large vessels and 5 to 10 minutes for small vessels. An adjustable salt water barrier extends across the upper miter sill for minimizing salt water intrusion into Lake Union.

Lake Union is in the geographical center of the City of Seattle. It has a fresh water frontage of about 8 miles and an area of approximately 800 acres. Lake Washington, which forms the eastern boundary of Seattle, is approximately 23 miles long and from 2 to 4 miles wide, with depths of up to 200 feet. The Kenmore Navigation Channel lies at the northern end of Lake Washington adjacent to the Sammamish River. Kenmore, an unincorporated industrial and business center in King County just north of Seattle, encompasses the lands to the north of the channel. Most of the waterfront facilities of the inner harbor are privately owned and handle barge traffic almost exclusively.

Four general anchorages are located in the outer harbor of Elliott Bay. Tides at Seattle have a mean range of 7.7 feet and a diurnal range of 11.4 feet. A range of about 18 feet may occur at the time of maximum tides. As a rule, the tidal currents in the outer harbor have little velocity. Channel depths of 34 feet or more are available to the Seattle waterfront. Of the nearly 60 piers and terminals in the outer harbor, the Port of Seattle owns 25, operating 3 and leasing out the others. There are 3 ferry slips in Elliott Bay with ferryboats operating 24 hours a day.

The Port of Seattle is a customs port of entry featuring slightly more than 220 piers, wharves, and docks. Waterfront facilities at the port are equipped to handle petroleum products including crude oil, miscellaneous liquid bulk materials other than petroleum, a variety of dry bulk commodities, and bunkering of large vessels. Oceangoing vessels are usually bunkered at berth by tank barges. Other facilities handle quarried material such as sand, gravel, stone, and clay; as well as cement, iron ore, slag, and gypsum. There are 2 waterfront grain elevators with a total capacity of nearly 7 million bushels. All grain is shipped in bags on pallets.

Floating equipment based at the Port of Seattle includes 102 diesel tugs and towboats with ratings ranging from 330 to 9,000 horsepower which are used for towing, docking, undocking, and shifting vessels. The services of the towing companies operating this equipment are not confined to the port limits, but extend to points in Puget Sound and along the Pacific Coast including Alaska. The port's equipment also includes 2 tank vessels (200 horsepower) with cargo-carrying capacities of 238 and 178 barrels for making deliveries of lube oils to vessels at berth.

B.4.3 PORT OF TACOMA

Tacoma Harbor is at the head of Commencement Bay, a southeasterly arm of Puget Sound. The Port of Tacoma is 29 nautical miles south of the Port of Seattle, and 142 nautical miles from the Pacific Ocean. The port district includes the entire area of Commencement Bay. From the ocean to the port, vessels traverse the Strait of Juan de Fuca, Admiralty Inlet, and Puget Sound. These waters are wide and have depths ranging from 200 to 900 feet. Tacoma's general anchorage is designated as a quadrilateral area off the north shore of Commencement Bay. As a rule, the depths elsewhere in the bay are too great for convenient anchorage. City regulations permit anchorage in any part of the bay outside the harbor lines so as not to interfere with vessels arriving or departing from their docks.

Commencement Bay is bordered by hills on the southwest and northeast and by extensive tidal flats on the Puyallup River Delta on the southeast. Commencement Bay is about 4 miles wide at the entrance between Point Brown and Point Defiance, has an average width of 2 miles, and a length of approximately 2.5 miles from Point Brown to the head of the bay. The Puyallup River, a glacial stream about 50 miles long, is the major tributary to the bay. The waters in Commencement Bay range in depth from 560 feet at the entrance to 100 feet at the head when they shoal abruptly to tidal flats. Eight waterways – Thea Foss, Middle, St. Paul, Puyallup, Milwaukee, Sitcum, Blair, and Hylebos (named in order from southwest to northeast) – have been dredged in the tidal flats and the spoil used to fill adjacent land.

The mean range of tide at Tacoma is 8.1 feet, and the diurnal range of tide is 11.8 feet. A range of about 19 feet may occur at the time of maximum tides. The tidal currents in the harbor have little velocity. Tugs with up to 3,000 horsepower are available at Tacoma, and larger tugs may be obtained from Seattle. A city ordinance prohibits speeds in excess of 5 knots on any of the waterways and within 200 yards of any shore or pier in the harbor. The Port of Tacoma has more than 30 deep-draft piers and wharves located on Hylebos, Blair, Sitcum, and Thea Foss Waterways and along the south shore of Commencement Bay. The terminal facilities include 23 deepwater berths ranging in depth from 35 to 65 feet. In addition to the port-owned properties, the harbor has numerous privately owned piers and wharves and many barge facilities.

Tacoma's container-handling operations are centered along the Blair and Sitcum Waterways at Commencement Bay. These two major waterways were recently dredged and deepened to accommodate large, maximum-draft vessels. Port facilities along the shallower Thea Foss, Middle, and St. Paul Waterways are equipped to ship and receive timber and petroleum products and provide marine repair services. Five wharves at Tacoma handle a variety of bulk liquids other than petroleum, such as caustic soda, chlorine, calcium carbonate slurry, sodium chlorate, and tallow. Other port facilities handle miscellaneous dry bulk materials, including crushed rock, sand, gravel, gypsum rock, salt, alumina, limestone, lime, copper slag, scrap metal, and wood chips.

Floating equipment available for use at the Port of Tacoma is continuously changing as tugs and towboats are widely dispersed throughout the Puget Sound area. The Foss Maritime Co. operates a fleet of approximately 70 tugs and towboats, with ratings of up to 5,000 horsepower, at various locations throughout the area. The company also operates tank barges with capacities ranging up to 30,000 barrels that are equipped with pumps for supplying bunker fuel to vessels at berth and to points on Puget Sound and adjacent inland waters. Floating equipment based at Tacoma includes tugs and towboats with ratings of up to 3,000 horsepower which are used for docking, undocking, towing, and shifting of vessels and barges, and for towing log rafts.

B.4.4 PORT OF OLYMPIA

The Port of Olympia is situated approximately 20 nautical miles southwest of Tacoma. Olympia Harbor is at the head of Budd Inlet, the southernmost waterway of Puget Sound traversed between Point Defiance at Commencement Bay. The inlet is approximately 6 miles in length and has an average width of 1 mile. The entrance to the inlet is deep except for the 28-foot shoal in the middle of the entrance. The shores are comparatively low and wooded, and the depths shoal less abruptly on the east than on the west side of the inlet. Natural depths in the inlet decrease from 100 feet at the entrance to 30 feet at the entrance of the dredged channel extending to the turning basin opposite the Port of Olympia Terminal.

No specific areas in Olympia Harbor have been designated as anchorage grounds. A good anchorage in muddy bottom may be found anywhere inside the entrance to the inlet, north of Olympia Shoal. A restricted area for Maritime Commission vessels lies on the east side of the inlet. The mean range of the tide at Olympia is 10.5 feet, and the diurnal range of tide is 14.4 feet. No large tugs are stationed in Olympia; however, tugs up to 3,000 horsepower are available from Tacoma and up to 5,000 horsepower from Seattle.

B.4.5 PORT OF GRAYS HARBOR

The Port of Grays Harbor, the only deep-sea shipping port on Washington's coast, is located in the southwestern part of the state and embraces the localities of Hoquiam, Aberdeen, Cosmopolis, and Westport. The deepwater entrance to the harbor from the Pacific Ocean lies between Point Brown on the north and Point Chehalis on the south, each of which is the terminus of a narrow, sandy peninsula. The entrance is 40 nautical miles north of the mouth of the Columbia River and 93 nautical miles south of the entrance to the Strait of Juan de Fuca. Grays Harbor is roughly pear-shaped, diverging from the Chehalis River at Aberdeen into a broad, shallow bay, and spreading out into North Bay and South Bay to a total width of about 13 statute miles. Its length from the ocean entrance easterly to Aberdeen is about 15 statute miles.

No specific areas in Grays Harbor have been designated for anchorage. The best anchorage is north of Westport and southeast of Damon Point in depths of 30 to 60 feet. The holding ground is good, and there is more swinging room than elsewhere in the harbor. At the entrance to the harbor, the average current velocity is about 1.9 knots on the flood and 2.8 knots on the ebb, but velocities may reach 5 knots. In the channels through the bay, velocities seldom exceed 3 knots. Currents in the vicinity of the bar are very erratic, setting north close inshore and south offshore.

Grays Harbor specializes in handling forest product and breakbulk commodities such as pulp, lumber, granite, steel, aluminum, containers, and machinery. A minus-36-foot (at zero tide) navigation channel provides easy access to the port facilities. There are 20 waterfront facilities serving Grays Harbor. The port also owns and operates 3 facilities in Aberdeen, one for providing bunker fuel and two others for handling conventional general cargo, lumber, and logs. The oil handling and bunkering terminal facility provides 450 feet of berthing space at 31-foot depth, and additional space for shallow draft, floating equipment.

Floating equipment available for use at Grays Harbor is subject to continuous change as tugs and towboats are widely dispersed throughout the area. Foss Maritime Co. operates a fleet of tugs and towboats with ratings of up to 5,000 horsepower, including the 1,700-horsepower tug ***Edith Foss*** which is based at the port. The company also operates tank barges from its Seattle base which are equipped with pumps for supplying bunker fuel to vessels at berth. These barges have capacities ranging up to 30,000 barrels.

B.4.6 PORT ANGELES HARBOR

Port Angeles Harbor is located on the southerly shore of the Strait of Juan de Fuca, about 62 nautical miles eastward from the Pacific Ocean, 69 nautical miles northwest of Seattle, and 19 nautical miles south of Victoria, B.C. The harbor is open to the strait on the east and is protected on the north and northwest by Ediz Hook, which is a low, narrow, and bare sand spit approximately 3 miles long, curving eastward from the mainland and offering shelter from the Pacific swells. The port is primarily a log export center. Other principal waterborne commodities include petroleum products, wood and paper products, seafood, and general cargo.

Passenger and vehicle ferries operate from the port to Victoria, B.C. Port Angeles is considered a major bunkering station, and is also the site of a U.S. Coast Guard station as well as the Puget Sound pilot station.

The harbor is about 2.5 miles long and about 1.5 miles wide at the entrance, decreasing in width to its head. The depths are greatest on the north shore and decrease from 180 to 90 feet in the middle of the harbor. Depths decrease regularly to the south shore where the 3-fathom curve, at certain locations off the easterly portion, is approximately 1,000 feet from the beach. Extra caution is advisable in navigating the waters inside Ediz Hook because of the large number of partially submerged logs in the area.

No specific areas in Port Angeles Harbor have been designated as anchorage grounds. The best anchorage is off the wharves in depths of 42 to 72 feet where the bottom is sticky. There are no mooring buoys in the harbor. Extensive log-booming grounds that are chartered in the north part of the harbor extend more than one mile from the west shore. Care must be taken when anchoring at night to avoid the rafted logs. The mean tidal range is 4.2 feet; the diurnal and extreme ranges are 7.2 and 14.5 feet, respectively.

Floating equipment based at the Ports of Northwest Washington includes 25 tugs and towboats with ratings of up to 4,200 horsepower, which are used for towing, docking, undocking, and shifting vessels, and one tank barge with a cargo-carrying capacity of 16,000 barrels for making deliveries of bunker fuel to vessels at berth. Oceangoing vessels are usually bunkered at berth by tank barges. Additional equipment based in Seattle can be dispatched as required.

B.4.7 PORT TOWNSEND

Port Townsend is located on the west side of Port Townsend Bay, at the entrance to Admiralty Inlet and Puget Sound. The port is 86 nautical miles eastward from the Pacific Ocean; 40 nautical miles northwest of Seattle; and 34 nautical miles southeast of Victoria, B.C. Ships enter Port Townsend Bay between Point Hudson and Marrowstone Point on Admiralty Inlet. The bay extends in a general south-southwest direction for 2.5 miles, and then south-southeast for 3 miles, with depths ranging from 30 to 120 feet. The port area extends approximately 2.5 miles along the west shore of the bay; depths alongside the berths range from 10 to 30 feet. Principal waterborne commodities include paper and wood products and seafood. Passenger and vehicle ferryboats operate between Port Townsend and Keystone, Whidbey Island, south of Anacortes.

The usual Port Townsend anchorage lies approximately 0.5 to 0.7 mile south of the port at Pleasure Boat Basin in depths of 48 to 60 feet and muddy bottom. In south gales, better anchorage is afforded close inshore off the north end of Marrowstone Island or near the head of the bay in moderate depths and muddy bottom. There are two explosives anchorages, one designated as a fair weather anchorage area and the other as foul weather anchorage area. The mean range of tide is 5.2 feet; the diurnal range is 8.5 feet, with an extreme range of about

16.5 feet. Because of the large daily inequality in the area, there may be only one high and one low water each day.

B.4.8 ANACORTES

The Port of Anacortes is located on the northern portion of Fidalgo Island, about 93 nautical miles eastward from the Pacific Ocean, 17 nautical miles south of Bellingham, and 66 nautical miles north of Seattle. From the ocean to the port, vessels transit the Strait of Juan de Fuca and Rosario Strait. Vessels bound for the port from the north use Bellingham Channel, which leads eastward from Rosario Strait between Cypress and Sinclair Islands on the west, and Guemes and Vendovi Islands on the east. Shallow-draft vessels proceeding to the port from the south frequently use Swinomish Channel and Padilla Bay. The principal waterborne commodities are crude oil, petroleum products, logs, lumber, seafood, and miscellaneous bulk materials.

Waterfront facilities are located along the south side of Guemes Channel, at Cap Sante Marina and Mooring Basin, on the east side of Fidalgo Bay, and on the east side of Swinomish Channel near its northerly end. The Cap Sante Waterway is an improved channel in the northwestern part of Fidalgo Bay. Guemes Channel separates Guemes Island on the north and Fidalgo Island on the south. The channel is about 3 miles long and ½ mile wide at its narrowest point, and extends eastward from Rosario Strait to Fidalgo Bay, a shallow arm of Padilla Bay. Swinomish Channel enters the southeast shore of Padilla Bay. Fidalgo Bay, a part of Anacortes Harbor, is generally shallow with depths ranging from about 8 feet in the central part to 1 or 2 feet on the tidal flats near the shore.

No specific areas are designated as anchorage grounds in Anacortes Harbor. Vessels may anchor in depths of 50 to 60 feet, about 0.8 mile east-northeast from Cap Sante Waterway Light 2. In the harbor, the mean tidal range is 4.8 feet and the diurnal and extreme ranges are 8.3 and approximately 15.5 feet, respectively. These tidal ranges are approximately the same at the Padilla Bay entrance to the Swinomish Channel.

B.4.9 EVERETT

Everett Harbor is located on the east side of Port Gardner, at the mouth of Snohomish River. Port Gardner is an easterly arm of Possession Sound, which lies between Whidbey Island on the west and the mainland on the east. Possession Sound connects Puget Sound on the south with Saratoga Passage and Port Susan on the north. Everett is 30 nautical miles north of Seattle, 63 nautical miles south of Bellingham, and about 117 nautical miles from the Pacific Ocean. From the ocean to the port, vessels traverse the Strait of Juan de Fuca, Admiralty Inlet, and the Puget and Possession Sounds.

The harbor proper extends southward approximately 4 miles from Preston Point at the mouth of the Snohomish River; the northernmost 2½ miles are essentially on the river delta. This northerly portion is shallow and generally bare at low tide, except for a dredged channel through which the flow of the river is partially diverted southward to Port Gardner by means of a training dike. The Snohomish River flows north through and along the east side of the City of Everett and west along its northern limits to a natural outlet at Preston Point. Smith Island is a delta formation on the north side of the river at its mouth. The principal commodities handled at the port are logs, lumber, wood products, alumina, and perishable food.

The designated general anchorage area is west of the Port Gardner waterfront in Possession Sound, beginning at a point 560 yards from Snohomish River Light 5. A buoy marks a submerged obstruction near the center of the anchorage. The mean range of tide is 7.4 feet; the diurnal and extreme ranges are 11.1 and 19 feet, respectively. Channel depths of about 22 feet or more exist at the main wharves in Port Gardner. Waterfront facilities for deep-draft vessels are located in the southern portion of the harbor on Port Gardner and East Waterway. Facilities for small vessels, barges, and log rafts are in the northern portion of the harbor, opposite the training dike near Preston Point, along both banks of the Snohomish River, and on Steam boat and Ebey Sloughs. Tugboats with ratings of up to 3,000 horsepower are available at Everett and larger tugs may be obtained from Seattle.

B.4.10 BELLINGHAM AND BLAINE

The Port of Bellingham is about 108 nautical miles from the Pacific Ocean, 80 nautical miles north of Seattle, and 63 nautical miles north of Everett. From the ocean to the port, vessels transit the Strait of Juan de Fuca, Rosario Strait, and Bellingham Channel. Vessels bound for the port from the south generally use the Bellingham Channel, which leads eastward from Rosario Strait between Cypress and Sinclair Islands on the west, and Guemes and Vendovi Islands on the east. Deep-draft vessels approaching Bellingham Bay from the north use the channel between the Lummi and Sinclair Islands. Shallow-draft vessels proceeding to the port from the south frequently use Swinomish Channel and Padilla Bay, and from the north they use Hale Passage.

Bellingham Harbor is located on the northeasterly shore near the head of Bellingham Bay. The bay is approximately 12 miles long and 3 miles wide and is open to the south and southeast. The harbor has a deepwater approach ranging from 96 feet in depth in the outer portion to 24 feet near the shore, except in the northerly portion where tidal flats extend about ¼ to ½ mile from the shore and where the bottom slopes gradually to deepwater. These tidal flats merge with the delta of the Nooksack River at the north end of the bay. Two anchorage areas have been established in Bellingham Bay, one designated as a general anchorage and the other designated as an explosives anchorage. The bottom of the bay consists of a thin accumulation of mud over hardpan forming rather poor holding ground in heavy weather.

Blaine Harbor, operated by the Port of Bellingham, is located 38 nautical miles north of Bellingham on the international boundary. The harbor is entered from Semiahmoo Bay, an arm of Boundary Bay on the Strait of Georgia. Waterfront facilities are located on Bellingham Bay, at Blaine Harbor, and several waterways in the area. The mean range of tide at Bellingham is 5.2 feet and the diurnal range is 8.6 feet. A range of about 14 feet may occur at the time of maximum tides. The mean range of tide at Blaine is 5.9 feet and the diurnal and extreme ranges are 9.5 and 17 feet respectively. The principal waterborne commodities handled at Bellingham and Blaine are logs, lumber, petroleum products, seafood, chemicals, and cement.

Floating equipment based at these ports includes 25 tugs and towboats with ratings of up to 4,200 horsepower, which are used for towing, docking, undocking, and shifting vessels. There is also 1 tank barge with a cargo-carrying capacity of 15,000 barrels for making deliveries of bunker fuel to vessels at berth. Additional equipment based in Seattle can be dispatched as needed.

APPENDIX B.5
DETAILED PORT INFORMATION ON THE
PORT OF CORPUS CHRISTI, TX

B.5.1 GENERAL

The Port of Corpus Christi is on the west side of Corpus Christi Bay, about 20 miles from the outer end of the jetties at Aransas Pass. Aransas Pass, located 154 miles southwest of Galveston Entrance and 113 miles north of the mouth of the Rio Grande, is the principal approach from the Gulf to Aransas and Corpus Christi Bays and their tributaries. The pass lies between San Jose Island on the north and Mustang Island on the south. Harbor Island is directly opposite the inner end of the pass and separates Aransas Bay from Corpus Christi Bay.

The entrance channel through Aransas Pass is protected by jetties. There is an outer bar channel 45 to 47 feet deep, a jetty channel 45 feet deep, and an inner basin at Harbor Island also with a depth of 45 feet. Corpus Christi Channel extends from Aransas Pass to Corpus Christi on the west side of Corpus Christi Bay. For about 4 miles at the east end, it extends through Turtle Cove between Harbor Island on the north and Mustang Island on the south, then across Corpus Christi Bay. The channel is straight except for a slight bend at its midway point just south of Ingleside Cove. The depth is 45 feet to the Tule Lake Turning Basin, 30.5 miles from the outer bar. A barge assembly basin with depths of 14 feet is located on the south side of the Corpus Christi Channel.

Harbor Island is at the head of Aransas Pass. Large oil-handling plants with berths are on the southeast end of the island. A dredged turning basin is east of the berths along the north side of the ship channel. A 5-mph speed limit is enforced in the channel and harbor from Harbor Island to the town of Aransas Pass. Corpus Christi Bay is a large body of water, roughly elliptical in shape, lying to the west of Mustang Island and connected with Aransas Pass by the Corpus Christi Channel. Mustang Island is a low, narrow strip of land that shelters the bay from the open waters of the Gulf of Mexico. Corpus Christi Bay is about 15 miles long in an east and west direction and 11 miles wide at its widest part. The depths are 8 to 11 feet at the east end of the bay and most of the rest of the bay has depths of 12 to 13 feet.

Corpus Christi's port limits include all of Nueces County, Texas. Corpus Christi Main Harbor encompasses all of the waterfront facilities along the Industrial Canal, Tule Lake Channel, and Viola Channel, and includes five turning basins: Corpus Christi, Avery Point, Chemical, Tule Lake, and Viola, the terminus of the Corpus Christi Ship Channel. Harbor Island, Port Aransas, Port Ingleside, and La Quinta are also part of the port area.

The Port of Corpus Christi Authority, headed by the Port Director, has jurisdiction and control over the port. The harbormaster assigns berths and enforces port regulations. Vessel activity is monitored continuously from the harbormaster's office at Wharf No. 1 on the south side of the Corpus Christi Turning Basin. A safe navigable speed is required within the harbor. The Port Authority also has jurisdiction over 5,030 acres of land on the south side of Nueces Bay and extending westward about 10 miles to include the mouth of the Nueces River.

Pilotage is compulsory for all foreign vessels and U.S. vessels under register in foreign trade. Pilotage is optional for coastwise vessels that have on board a pilot licensed by the Federal Government. The Aransas-Corpus Christi Pilots serve Aransas Pass Outer Bar and Jetty Channel, Corpus Christi Ship Channel to Viola Basin, and La Quinta Channel. The pilots board vessels between the sea buoy, Aransas Pass Entrance Lighted Whistle Buoy AP, and Lighted Buoy 3. The pilots maintain an office and lookout on the south jetty. They maintain a 24-hour watch and carry portable VHF-FM radiotelephones. Pilot services are available 24 hours a day, and arrangements for services are usually made through the Corpus Christi marine operator, through the harbormaster, through ship's agents, or by radiotelephone to the pilot station or harbormaster. The harbormaster, pilot station, pilot boat, and all tugs and pilots maintain radio communications for docking, undocking, and all harbor movements.

Vessels can anchor in the Gulf of Mexico off Aransas Pass in the Aransas Pass Safety Fairway and Aransas Pass anchorage areas. There is no suitable anchorage for deep-draft vessels inside Aransas Pass. Light-draft vessels up to 10-foot draft can anchor in Lydia Ann Channel, north of Inner Basin. Small vessels may also anchor in Corpus Christi Bay in depths up to 13 feet and behind the breakwater off Corpus Christi in depths up to 15 feet. Under certain conditions, large vessels may be anchored to short scope in the port's turning basins. A special anchorage area is designated in the bay at the southernmost T-head pier at the foot of Cooper Avenue.

Corpus Christi Harbor consists of five inland turning basins which are connected by the Industrial Canal, Tule Lake Channel, and the Viola Channel. The basins and connecting canal are landlocked and well protected. The bay waterfront at Corpus Christi is protected by a breakwater nearly 2 miles long. Depths in most of the area behind the breakwater range from 5 to 17 feet, not including the ship channel crossing the north end. The main entrance is through the ship channel. Depths of 5 to 6 feet can be carried south inside the breakwater to three large wharves of the municipal marina, about 0.7 mile south of the ship channel. Vessels should pass inshore of the center of this protected waterway. There are four openings in the breakwater south of the ship channel; the southernmost opening has depths of about 7 feet and provides smaller vessels with a direct entrance to the marina from the bay.

The diurnal range of tide at Aransas Pass is 1.4 feet. In Corpus Christi Bay the periodic tide is too small to be of any practical importance. The currents at times have velocities exceeding 2.5 knots in Aransas Pass; they are greatly influenced by winds. Currents outside Aransas Pass are variable; southbound currents when reinforced by northerly winds have produced a drift that has been reported as high as 4 knots across the mouth of the jetties. Winds from any east direction make a rough bar and raise the water inside as much as 2 feet above the normal. A sudden shift of the wind from south to north makes an especially rough bar for a short time.

Corpus Christi has more than 100 piers and wharves which are equipped to handle the port's waterborne commerce. Principal imports include crude oil, bulk ores, petroleum products, chrome, and paints; exports include wheat and other grains, petroleum products, aluminum, industrial chemicals, synthetic rubber, machinery, and general cargo. The port facilities are located in the Outer Harbor on the Corpus Christi Ship Channel, on the Gulf Intracoastal Waterway, on the east side of Harbor Island, on La Quinta Channel, and on Jewell Fulton Canal. The facilities in the Inner Harbor are situated along a 9-mile stretch of dredged channels and basins.

The G. & H. Towing Company is based at the port and performs towing, docking, undocking, and shifting services for vessels in Corpus Christi Harbor. This company operates 5 diesel-powered tugboats with ratings ranging from 1,700 to 4,000 horsepower which are permanently based at Corpus Christi. Towing services are not confined to the limits of the port, but extend to other points along the Gulf of Mexico, the Gulf Intracoastal Waterway, and the Atlantic Coast. Additional floating equipment based at the port consists of two tank barges, each with a cargo-carrying capacity of 20,000 barrels and equipped with pumps for making deliveries of bunker fuel to vessels at berth. These tank barges are towed by a tug with a rating of 800 horsepower.

APPENDIX B.6
DETAILED PORT INFORMATION ON
THE PORT OF TAMPA, FL

B.6.1 GENERAL

The Port of Tampa is on Hillsborough Bay and on the east side of Old Tampa Bay, 232 nautical miles north of Key West, Florida, and 383 nautical miles southeast of Mobile, Alabama.

Tampa Bay, a large natural indentation about midway along the west coast of Florida, is one of the important harbors of the Gulf coast and is easily accessible day or night. The bay extends northeast from the Gulf of Mexico for about 20 miles and is 6 to 7 miles wide. It has two arms which roughly form a "Y" of which Tampa Bay proper constitutes the stem, Old Tampa Bay is the westerly branch, and Hillsborough Bay is the easterly branch. Hillsborough Bay is about 8 miles long and 4 to 5 miles wide, and Old Tampa Bay is 12 miles long and 2.5 to 6 miles wide. The two bays are separated by the Interbay Peninsula.

From the Gulf, deep-draft vessels enter Tampa Bay through Egmont Channel, which passes between Mullet Key on the north and Anna Maria Key on the south, 4.5 miles apart. Egmont Channel, the main deepwater ship channel, has been dredged through shoals that extend about 6 miles west of the entrance. A buoy 13.5 miles west of Egmont Key marks the approach to the bay. Egmont Key is a low, sandy, and wooded island about 1.6 miles long which is almost in the middle of the entrance to Tampa Bay. A pilot station lookout tower is near the center of the island. A one-way traffic pattern has been established in Egmont Channel to protect vessels with a draft of greater than 36 feet. The main ship channel continues through Mullet Key Channel and dredged cuts leading up the bay through Tampa Bay, Hillsborough Bay, and Old Tampa Bay.

The Port of Tampa is under the direction of the Tampa Port Authority and includes Tampa proper, Port Tampa, Big Bend, and the mouth of the Alafia River. The Authority is composed of a five-member board appointed by the Governor of Florida. The board appoints a Port Manager to administer the regulations established by the Authority. The Greater Tampa Bay Marine Advisory Council and the Coast Guard Captain of the Port of Tampa recommend specific guidelines regarding the movement of vessels in and out of the port.

Pilotage is compulsory for all foreign vessels drawing 7 feet or more. It is optional for U.S. vessels sailing coastwise under license and enrollment which have on board a pilot licensed by the Federal Government. Pilotage services are provided by the Tampa Bay Pilots. The pilot station is located mid-length of Egmont Key. Pilots board vessels day and night, usually in Egmont Channel. Vessels are requested to enter Egmont Channel and proceed inbound, maintaining a speed of 7 to 8 knots for pilot boarding.

Vessels with good ground tackle should anchor in the Tampa anchorage areas north of the Tampa Safety Fairway leading to Egmont Channel. The usual inside anchorages are south of Mullet Key in depths of 30 to 35 feet, and southwest of Gadsden Point in natural depths of 29 to 35 feet. The Tampa Bay Pilots have imposed a restriction of 675 feet in length and 27 feet in draft for vessels in the Gadsden anchorage. Explosives and quarantine anchorages are east of Mullet Key, northeast of Papys Point, and south of Interbay Peninsula.

The diurnal range of tide in Tampa Bay is about 2.3 feet. A strong offshore wind sometimes lowers the water surface at Tampa and in the dredged channels as much as 4 feet, and retards the time of high water by as much as 3 hours. A continued southwest wind raises the water by nearly the same amount and advances the time of high water by as much as one hour. There is a large daily inequality in the ebb, and velocities of 3 knots or more may be expected at the strength of the greater ebb of the day in Egmont Channel, Passage Key Inlet, and off Port Tampa. Flood velocities seldom exceed 2 knots. Winds have considerable effect in modifying the tidal current. At 6.7 miles west of Egmont Key, the tidal current is rotary, turning clockwise, and has considerable daily inequality. The strengths of the greater floods and ebbs set north and south, respectively.

The port has more than 110 piers, wharves, and docks available to handle waterborne commodities. There is considerable foreign and domestic trade in shipments of phosphate rock, petroleum, liquid sulfur, cement, chemicals, cattle, fruit, grain, scrap iron, machinery, and general cargo. Most of the facilities are situated along the Hillsborough, Seddon, Sparkman, Garrison, and Ybor connecting channels and turning basins; the remaining facilities are along the river and bay waterfronts in the port area.

The Port of Tampa has several towing companies with tugs of ratings up to 6,000 horsepower. Some tugs are equipped for fire-fighting. Large vessels usually require at least two tugs. Tampa Bay pilots have established recommendations with respect to dead ship movements: Vessels 350 feet or less require 1 assist tug plus towing vessel; vessels 350 to 500 feet require 2 assist tugs plus towing vessel; vessels 500 to 650 feet require 3 assist tugs plus towing vessel; vessels 650 feet or more require 4 assist tugs plus towing vessel. A towing tug is not required in intra-bay transit. Tugs of up to 2,400 horsepower are based at Port Manatee, a deepwater terminal on the southeast side of Tampa Bay, about 11 miles above Egmont Key.

The city of Tampa is at the head of Hillsborough Bay at the mouth of Hillsborough River, about 41 miles from the Gulf entrance. Hillsborough River flows southward through the city into the turning basin at the north end of Seddon Channel. The head of navigation in the river is the City Water Works Dam, 10 miles above the mouth. A part of the waterfront at Tampa is on triangular-shaped Seddon Island at the northern end of Hillsborough Bay. Each of the island's three sides is coursed by dredged channels. At the southern tip of the island, the Hillsborough Bay Channel divides into Seddon and Sparkman Channels on the west and east sides, respectively. These channels are interconnected by Garrison Channel on the north side of the island. Seddon Channel is extended northward by a shallow-draft channel in the lower reaches of Hillsborough River. Sparkman Channel is extended northward by Ybor Channel to the industrial section of the city. Two turning basins – the Hillsborough at the mouth of the Hillsborough River and the Ybor at the entrance to Ybor Channel – are at the west and east ends of Garrison Channel at its junction with Seddon and Sparkman Channels, respectively. Davis Islands, and a mainland extension terminating at Hookers Point lies adjacent to the east side of Sparkman Channel.

Port Tampa is on the westerly side of the Interbay Peninsula on Old Tampa Bay, about 18 nautical miles via the deep-draft channels from the Tampa waterfront at Hookers Point. Port Tampa and Port Sutton have large slips and waterfront facilities equipped to accommodate oceangoing vessels. Weedon Island, located west of Port Tampa across Old Tampa Bay, and Big Bend, located east of Gadsden Point across Hillsborough Bay, have privately maintained channels leading to power plant terminals.

APPENDIX B.7
DETAILED PORT INFORMATION ON PATAPSCO RIVER PORTS INCLUDING THE PORT OF BALTIMORE, MD

B.7.1 GENERAL

The Port of Baltimore, one of the major ports of the United States, is situated at the head of the navigable tidewater portion of the Patapsco River. Located approximately 12 miles northwesterly from the 4,400-square mile Chesapeake Bay, the largest estuary in the United States, the harbor area consists of the entire Patapsco River and its tributaries. The port is 150 nautical miles north of the Virginia Capes, the entrance from the Atlantic Ocean to the Chesapeake Bay. The bay is 168 miles long with a greatest width of 23 miles and represents the largest inland body of water along the Atlantic coast. The Patapsco River enters the west side of the Chesapeake Bay between Bodkin Point and North Point, 4 miles to the north, about 9.5 miles below Fort McHenry at Baltimore. The river is about 4 miles wide at its mouth, between North and Bodkin Points.

Chesapeake Bay is the approach to Baltimore, Norfolk, Newport News, and many lesser ports. Deep-draft vessels use the Atlantic entrance, which is about 10 miles wide between Fishermans Island on the north and Cape Henry on the south. Medium-draft vessels can enter from Delaware Bay on the north by way of the sea level Chesapeake and Delaware Canal, a distance of 113 nautical miles. The canal extends from Reedy Point, Delaware, to the Chesapeake Bay, and provides unencumbered ship passage between Baltimore and other North Atlantic ports. Light-draft vessels can enter Baltimore from Albemarle Sound on the south via the Intracoastal Waterway.

The port area of Baltimore includes the navigable part of the Patapsco River below Hanover Street, the Northwest and Middle Branches, and Curtis Bay and its tributary Curtis Creek. The Northwest Branch, known locally as the Inner Basin, extends about 3 miles in a northwesterly direction from Fort McHenry to its head at Calvert Street, and varies in width from 1,200 to 3,000 feet. Middle Branch, also known locally as Spring Garden, extends about 1.5 miles in a northwesterly direction from Ferry Bar past Hanover Street to the foot of Eutaw Street, and varies in width from 1,000 to 4,000 feet. Curtis Bay is an estuary, about 2 miles long and 0.7 mile wide, on the southwest side of the Patapsco River, 6 miles above the river mouth. Curtis Creek empties into the head of Curtis Bay from southward between Sledds and Ferry Points, on the southwest side of Curtis Bay.

Pilotage is compulsory for all foreign vessels and for U.S. vessels under register in the foreign trade bound to or from the Port of Baltimore. Pilotage is optional for U.S. vessels under enrollment in the coastwise trade who have on board a pilot licensed by the Federal Government for these waters. The Association of Maryland Pilots offers pilotage for any vessel between Baltimore and the Virginia Capes, and between Baltimore and the Maryland entrance to the Chesapeake and Delaware Canal at Chesapeake City, Maryland. The Maryland pilots also serve Maryland ports in the tributaries of Chesapeake Bay and the District of Columbia. Maryland pilots board vessels bound for Baltimore at Cape Henry. The docking pilots board vessels at North Point or Key Bridge depending on location of the destination dock.

The Association of Maryland Pilots maintains a station on the north bank of the Chesapeake and Delaware Canal at Chesapeake City, where the exchange of pilots takes place. Vessels proceeding from Chesapeake City to Washington, D.C. or the lower part of Chesapeake Bay, when using Maryland pilots, sometimes transfer pilots at a designated transfer area in Chesapeake Bay off the entrance to Patuxent River or on the Potomac River off Piney Point, depending on the port of call. When vessels proceed to Virginia ports, the Maryland pilots are replaced by pilots of the Virginia Pilots Association off the mouth of Severn River (approach to Annapolis, Maryland).

The Chesapeake and Interstate Pilots Association offers pilot services to U.S. vessels engaged in the coastwise trade, and public vessels to or from Baltimore via the Chesapeake Bay if the vessel is entering from the sea at Cape Henry or transiting between any port or place on the Chesapeake Bay and its tributaries. Pilot service is also offered to vessels to or from Baltimore that are transiting the Chesapeake and Delaware Canal. The pilots will meet vessels upon prior arrangement at Cape Henlopen or any port or place on the Delaware Bay and River, and at Cape Henry or any port or place on the Chesapeake Bay and its tributaries. These pilots will also meet vessels at various ports in the northeast and provide all pilot services required from the port of departure to the port of arrival. The Association of East Coast Pilots offers pilotage to public vessels and U.S. vessels in the coastwise trade that are transiting between Baltimore by way of the Chesapeake and Delaware Canal and many ports northeast.

A regulated navigation area has been established in the waters of the Atlantic Ocean and in Chesapeake Bay. Traffic separation schemes have been established for the control of maritime traffic at the entrance of Chesapeake Bay and off Smith Point Light. These schemes have been designed to aid in the prevention of collisions, but are not intended in any way to supersede or alter the applicable Navigation Rules. The scheme provides inbound-outbound traffic lanes for entering or departing Chesapeake Bay from the northeast and from the southeast.

A precautionary area with a radius of two miles is centered on the Chesapeake Bay entrance junction. Extreme caution should be exercised where two routes converge off Cape Henry. Vessels may be maneuvering in the pilotage area which extends into the western part of the precautionary area. The waters surrounding a vessel that is carrying liquefied petroleum gas are considered to be a safety zone while the vessel transits the Chesapeake Bay and Elizabeth River.

The mean range of tide is 1.1 feet at Baltimore and 2.8 feet at Cape Henry. Prolonged winds of constant direction may cause substantial variation in the tide. The current velocity is 1.0 knot on the flood and 1.5 knots on the ebb in the entrance to the Chesapeake Bay. The current velocity at Baltimore is 0.8 knot on the flood and ebb; currents in the harbor area are generally too weak and variable to be predicted. There are six general anchorage areas in the Patapsco River of Baltimore Harbor, including two that are designated for deep-draft vessels and four that are designated for vessels with specific drafts of less than between 19 and 30 feet. Other established anchorage areas include one reserved anchorage, one designated for dead ships, and one small vessel anchorage to be used only by vessels 100 feet in length or less.

The channel depths in the Baltimore Harbor are 50 feet in the main channel between the Virginia Capes and Fort McHenry; 42 feet in the east section of the Ferry Bar Channel and turning basin; 49 feet in the Northwest Harbor East Channel and turning basis; 40 feet in the Northwest Harbor West Channel and turning basin; and 50 feet in the Curtis Bay Channel. The main channel between the Delaware Capes and Baltimore by way of the Chesapeake and Delaware Canal is 35 feet deep. A 6-knot speed limit is enforced in the Inner Harbor at the head of Northwest Harbor.

The Baltimore Maritime Exchange, located on the Baltimore Recreation Pier, provides information concerning ship movements, local harbor conditions, weather data, and various other services. Baltimore Harbor comprises approximately 45 miles of waterfront area encompassing nearly 1,600 acres of sheltered waters. A part of the port included in this area lies outside the municipal limits of Baltimore; however, state law places the entire port complex under the jurisdiction of the Maryland Port Administration which is part of the Maryland Department of Transportation. The Port Administration has general jurisdiction over the physical operation of Baltimore Harbor and issues rules and regulations pertaining to the use of the port’s public facilities. More than 200 piers, wharves, and docks are equipped to handle the port’s principal waterborne commerce. Commodities consist of both containerized and conventional general cargo as well as dry and liquid bulk products. Several municipal piers, administered by the city harbormaster, are used mainly by coastwise vessels.

Floating equipment based at the Port of Baltimore is available to provide docking and towing services as well as bunkering fuel and fresh water to vessels at berth and in the harbor. Equipment includes about ten tugs with ratings of up to 3,800 horsepower which are ready at all times to assist vessels arriving or departing, in docking or undocking, and in shifting within the harbor. Long distance towage is also provided whenever needed.

APPENDIX B.8
DETAILED PORT INFORMATION ON
THE PORT OF COOS BAY, OR

B.8.1 GENERAL

The Port of Coos Bay is in the southwestern part of the State of Oregon and includes all of Coos Bay and its tributaries. Coos Bay is a U-shaped body of water about 13 statute miles long and one mile wide with an area of about 15 square miles at high tide. The deep-water entrance to the bay from the Pacific Ocean is about 384 nautical miles north of San Francisco, California, and about 200 nautical miles south of the Port of Astoria, Oregon, at the mouth of the Columbia River. Coos River, formed by the confluence of the South Fork and Millicoma River, flows into the southeastern end of the bay. The Port of Newport is located in the northwestern part of Oregon, on Yaquina Bay at the mouth of the Yaquina River, 113 nautical miles south of the Port of Astoria. Yaquina Bay is a tidal estuary, the harbor itself being merely the widening of Yaquina River just inside the entrance.

Coos Bay is the largest coastal deep-draft harbor between San Francisco and Puget Sound. Noted for having the safest entrance bar on the northwest coast, the Coos Bay channel was deepened by two feet in 1996. This navigation improvement combined with a short 15-mile channel route provides for increased inbound and outbound cargoes that move rapidly and efficiently. One of the largest forest products ports in the world, Coos Bay is used as a harbor of refuge and can be entered at any time except in extreme weather. The entrance to the bay is protected by jetties, and there is usually a current sweeping either north or south just off the jetties. The currents are variable and uncertain; velocities of 3 to 3.5 knots have been observed offshore and greater velocities have been reported. The most favorable time for crossing the bar is on the last of the flood current, and occasionally it is passable only at this time.

Pilotage is compulsory for all foreign vessels and U.S. vessels under register. Pilotage is optional for U.S. vessels in the coastwise trade that have onboard a pilot licensed by the Federal Government for these waters. The Coos Bay Pilots Association serves Coos Bay and its tributaries. The pilots usually board vessels about one mile seaward of the Coos Bay Approach Lighted Whistle Buoy K. Vessels are requested to maintain a speed of about 8 knots during the pilot boarding process. The pilots for Yaquina Bay are associated with the Coos Bay Pilots Association, and are based in Coos Bay.

An anchorage for deep-draft vessels with good holding ground in sand bottom is available outside and to the north of the bay entrance. Anchorage for small craft is available almost anywhere in the bay outside the dredged channels and below the railroad bridge. An anchorage basin 1,000 feet long and 800 feet wide with 35 feet of depth has been constructed inside Coos Bay at mile 5.5, but it is not currently maintained. There are no anchorages for deep-draft vessels at Yaquina Bay.

The mean range of tide at Coos Bay is 5.6 feet, and the diurnal range of tide is 7.3 feet. A range of about 12 feet may occur at the time of maximum tides. The current velocity in the entrance to Coos Bay is about 2 knots. The greatest observed ebb velocity was a little more than 3 knots. During long runouts, an ebb current of 5 knots has been reported at Guano Rock. The mean range of tide at Newport is 6.0 feet, and the diurnal range of tide is 8.0 feet. The current velocity is about 2.4 knots on the flood and 2.3 knots on the ebb in Yaquina Bay entrance. Near Newport docks, the velocity is about 0.5 knot; off Yaquina and 1 mile south of Toledo, the velocity is about 1.4 knots.

The Port of Coos Bay, including facilities at the cities of Coos Bay and North Bend, has more than 10 deep-draft piers and wharves with about 15 deep-draft berths. Altogether, there are about 60 piers, wharves, and docks located at Coos Bay and Newport. Floating equipment serving Coos Bay and Newport includes about 20 tugs with ratings up to 2,000 horsepower. The tugs are used for towing, docking, undocking, and shifting vessels. Three of the tugs at Coos Bay are also used as pilot boats. These are the largest tugs available and do most of the dock assist work in the port.

The principal waterfront facilities at Coos Bay are those located at Charleston, near the entrance, at the localities of Empire, North Bend, Coos Bay and Bunker Hill on the western and eastern arms of the bay and the upper bay, and at Eastside on the Coos River. Logs and lumber are the principal waterborne commodities handled at North Bend, Coos Bay, Bunker Hill, and McLean Point. The main waterfront facilities for the Port of Newport are located in Newport, at McLean Point on the north side of the bay, and at South Beach on the south side. The majority of facilities at Charleston and Newport are used by fishing vessels.

Public and private terminals at Coos Bay are equipped to handle all types of forest products, breakbulk cargoes, and bulk commodities. Twelve terminals provide 13 deep-draft berths, five barge facilities, and two special purpose moorages. More than 4.5 million tons of cargo move through the harbor annually, with an average of 250 deep-draft vessel and 120 cargo barge calls.

APPENDIX C

PORT CONTACTS

PORT CONTACTS

The marine exchanges and port authorities were contacted to obtain data are listed in Table C-1. In the search for usable electronic data on port activity, many dead ends were reached. Table C-1 indicates those ports which keep electronic data and those we contacted but did not result in data.

Table C-1. Port Contacts

Port	Contact	Comments
Philadelphia	Philadelphia Maritime Exchange Scott Anderson (215) 925-1524	Purchased data from Marine Exchange
Virginia	Hampton Roads Maritime Association Ron Williams	Just implemented data tracking system in February 1997
Houston	Houston Marine Exchange Alton Landry	Do not keep electronic data
Corpus Christi	Port Authority Marvin Moonie (512) 885-6149	Purchased data from Port Authority
Port of South Louisiana	New Orleans Board of Trade Gene Hymel (504) 525-3271	Purchased data from Board of Trade
Alaska	Port of Anchorage	Only record vessel arrivals by month in a log book
Tampa	Tampa Port Authority Lori Rafter (813) 272-0550	Purchased data from Port Authority
Baltimore	Baltimore Maritime Exchange David Stanbaugh (410) 342-6610	Purchased data from Marine Exchange
Miami	Port of Miami Andrew Diamond (305) 371-7678	Could not provide electronic data
Chicago	Chicago International Port Authority John Shiphorst	Did not have data in one place for the port

Table C-1. Port Contacts (Continued)

Port	Contact	Comments
Detroit	Steven Olinek (800) 249-7678	Could not provide electronic data
Toledo	Kelly Revera (419) 243-8251	Did not have detailed information electronically
Burns Harbor	Pete McCarthy (219) 787-8636	Provided electronic data
Duluth Superior	Davis Helberg (218) 727-8525	Did not have electronic data
Cleveland	Dharma Wilson Cleveland Port Authority (216) 214-8004	No electronic data - Received log book copies
New Haven	Jim Shine (203) 469-1391	Dead end
Coos Bay	Coos Bay Marine Exchange Martin Callery (541) 267-7678	Purchased data from Marine Exchange
Seattle	Puget Sound Marine Exchange Jim Friberg (206) 443-3830	Purchased data from Marine Exchange
New York New Jersey	Maritime Association of the Port of New York/New Jersey Terry Benson (212) 425-5704	Purchased data from Marine Exchange
Cincinnati	Donald Leavitt (501) 862-1471	Dead end
St. Louis	St. Louis Port Authority Nick Nichols 314-622-3400 x264	No electronic data but good source of some data on the port