February 2004

Volume II of II

FINAL

Economics – Appendix A

Engineering – Appendix B

Real Estate – Appendix C

Pertinent Correspondence – Appendix D

Preliminary Assessment - DMMP – Appendix E

Mitigation Plan – Incremental Cost Analysis – Appendix F

For the

Miami Harbor Navigation Study General Reevaluation Report

Miami-Dade County, Florida - 010140

US Army Corps of Engineers®

Jacksonville District
South Atlantic Division

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

LOCATION

The Port of Miami is an island facility consisting of 660 acres that is located at the northern part of Biscayne Bay in South Florida. The city of Miami is located on the west side of Biscayne Bay; the city of Miami Beach is located on a peninsula on the northeast side of the bay, opposite Miami. Both cities are located in Miami-Dade County, Florida, and are connected by several causeways crossing the bay. The Port is the southernmost major Atlantic Coast port (see **Figure A-1**). Referenced to other major South Atlantic Region ports, the Port is located 21 nautical miles south of Port Everglades (Fort Lauderdale), Florida; 83 nautical miles south of Palm Beach, Florida; 173 nautical miles south of Port Canaveral, Florida; 306 nautical miles south of Jacksonville, the most northern port on Florida's Atlantic Coast; 386 nautical miles south of Savannah, Georgia; and 420 nautical miles south of Charleston, South Carolina. It is 144 nautical miles north of Key West, the southernmost port in Florida.

FEDERAL PROJECT

The present Federal navigation project consists of:

(1) An entrance channel, with a 44-foot depth over a bottom width of 500 feet from the ocean to the beach line, with two rubble stone jetties;

(2) An inner channel (Government Cut) with a 42-foot depth and bottom width of 500 feet from the beach line to the Fisher Island turning basin;

(3) The Fisher Island turning basin with a 42-foot depth over a triangular-shaped bottom area;

(4) A channel (Fisherman's Channel) with a 42-foot depth over a bottom width of 400 feet from the Fisher Island turning basin along the south side of Lummus Island to the Lummus Island turning basin;

(5) The Lummus Island turning basin with a 42-foot depth and a turning diameter of 1,500 feet;

(6) A channel with a 34-foot depth over a bottom width of 400 feet extending west 1,200 feet from the Lummus Island turning basin;

(7) A (Main) channel with a 36-foot depth over a bottom width of 400 feet from the Fisher Island turning basin west along the north side of Lummus and Dodge Islands to a third turning basin;

(8) A (Main) turning basin with a 36-foot depth with a turning basin diameter of 1,650 feet at the west end of the 36-foot Main Channel;

(9) A channel with a 15-foot depth in the Miami River over a varying bottom width of 150 feet at the mouth to 90 feet 5.5 miles inland; and

(10) Maintenance of the constructed project.

PURPOSE AND SCOPE

The current project features for the inner (Government Cut) and Fisherman's channels and the Fisher Island turning basin were designed for Panamax container ships; however, the world container ship fleet has significantly changed since these features were authorized in 1989. Since 1989, Post-Panamax container ships that were deployed in the Far East trade region (Europe/Mediterranean/Far East trade route) have become more numerous and are now deployed in the Pacific trade region (U.S. West Coast/Far East trade route). It is anticipated that within the next five years, Post-Panamax container ships will be deployed in the Atlantic trade region and will call at U.S. East Coast ports. Thus, one purpose of this economic analysis is to estimate the National Economic Development (NED) benefits associated with harbor improvements, specifically channel deepening, that are designed to allow for the efficient utilization of Post-Panamax container ships.

In addition to assessing the NED benefits of channel deepening, the economic analysis will also estimate the NED benefits of improvements designed to remedy navigation problems within the harbor that were identified in a letter from the Biscayne Bay Pilots to the Port Authority, dated October 23, 1997. The improvements call for widening the project channels at three locations.

The first location is the outer entrance channel at Outer Bar Cut. "The currents in this area are variable and unpredictable, putting large deep draft vessels at risk when making their approach to Miami.... Several container ships have already grounded off Buoy 1." The Pilots recommended that the outer channel be tapered with an 800-foot wide entrance.

The second area is on the south side of Government Cut between Beacon 13 and Beacon 15. In this area, ships are turning from one channel to another (Government Cut to Fisherman's Channel). "The strong currents in this area compounded by the necessity for the ship to have as little speed as possible, makes it important for the ship to have as much swinging room as possible.... Tugboats assisting ships in this area have grounded and sustained damage." The Pilots recommended widening the channel between Beacons 13 and 15 as much as possible.

The third area of concern is the Lummus Island Cut (Fisherman's Channel), just south of the gantry crane area. Ships transiting the Fisherman's Channel pass extremely close to vessels docked at the gantry crane berths on Dodge Island. This results in a "surging" effect on the ships at the berths. Moreover, frequently vessels with on-board cranes have their cranes swung outboard 90 degrees, thereby blocking a portion of the channel. "Given the variables of wind, current, ship size, draft, etc., this creates an unsafe condition." The Pilots recommended that the southern edge of the Lummus Island Cut be extended 100 feet further to the south.

The number of people taking cruises has been growing, and this growth is expected to continue in the future. In response to this increasing demand, cruise ship companies have been constructing larger cruise ships to carry more passengers. The largest cruise ships in the world are Royal Caribbean International's VOYAGER-class cruise ships. Two of these vessels, the VOYAGER OF THE SEAS and the EXPLORER OF THE SEAS, currently homeport at Miami Harbor. These cruise ships are 1,019 feet long and carry 3,114 passengers. Because of the increase in size, both length and breadth, of cruise ships, the amount of berthing area at the current cruise ship terminals has been reduced. To provide more berthing area for cruise ships, the Port is berthing small cruise ships at Cruise Terminal 12 located at the southwest corner of Dodge Island. Terminal 12 serves Passenger Bays 183 to 195.

Because cruise ships will continue to increase in size, harbor improvements will be required to accommodate the larger cruise ships at Bays 183 to 195. Accordingly, NED benefits will be estimated for extending the current Federal channel from a point 1,200 feet west of the Lummus Island turning basin to the southwest corner of Dodge Island (Passenger Bay 195) and constructing a separate turning basin within this segment.

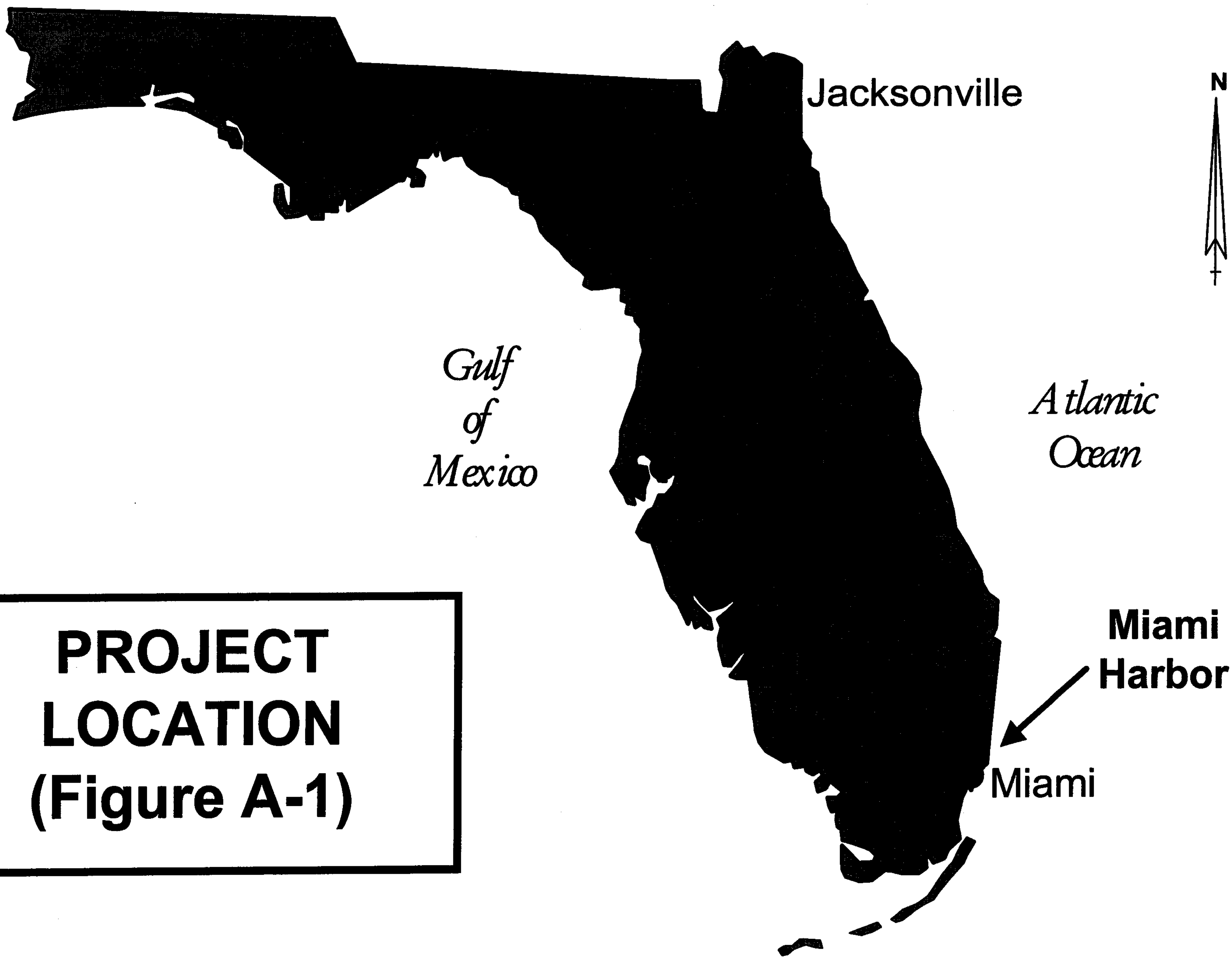
The purpose of the benefits analysis is to estimate NED benefits associated with harbor improvements designed to accommodate larger, more efficient cruise and container ships and to eliminate or significantly reduce the navigation problems that have been identified by the Biscayne Bay Pilots. Because this is a General Reevaluation Report (GRR), the analysis was conducted at a level of detail commensurate with a feasibility study.

PORT INFRASTRUCTURE

The Port of Miami is a 660-acre island facility created from two spoil islands, Dodge Island and Lummus Island. As shown in **Figure A-2**, the western end is Dodge Island, and the eastern end is Lummus Island. The Port is connected to the Miami mainland by two bridges, a 65-foot high, fixed span vehicular bridge and a road and a rail bridge linking to the Florida East Coast Railroad Company's main line track.

The Port of Miami is a "clean port", the designation of a seaport that does not handle bulk cargoes or potentially dangerous or hazardous cargoes such as fuel oil. The Port handles only palletized, roll-on/roll-off (RO/RO), and containerized cargo. In addition to cargo traffic, the Port of Miami is also a major cruise ship port. It is the year-round homeport of the largest cruise ship in the world, the VOYAGER OF THE SEAS. As reported in the 1999 Port of Miami Master Development Plan (April 30,1999), the Port consists of 518 acres of actual landmass. Of the 518 acres, 372.5 acres (71.9 percent) is devoted to cargo operations, mainly on Lummus Island, and 52 acres (10.0 percent) is devoted to cruise operations on Dodge Island. The Port also leases 34 acres from the Florida East Coast Railway at its Buena Vista yard, which is located approximately 2.5 miles northwest of the Port. This leased property is used as an intermodal container marshaling and storage area for transshipments.

The Port of Miami is a landlord port, owned by Miami-Dade County, Florida and managed by the Miami-Dade County Seaport Department. The Port Director reports to the County



PROJECT LOCATION (Figure A-1)

NOTES:
1] DRAFT Environmental Baseline Resource Survey (underwater features) provided February 2001, by Dial Cordy & Associates, Jacksonville Beach, FL
2] USACE Survey Number 00-058, March 2000
3] Beacons, aids to navigation, and soundings are in approximate locations based on NOAA Nautical Charts (number 11468, 36th Ed., July 24 1999, and number 11466, 34th Ed., February 6 1999)
4] Elevations in feet and refer to mean lower low water
5] Projection Stateplane Coordinate System, NAD27, Fipszone 0901
6] Background aerial photos taken September 1 1999

LEGEND:

Existing Navigation Channel
- Existing Centerline
- Existing Channel Edge

Proposed Components
- Cmp1c
- Cmp2a
- Cmp3b
- Cmp4
- Cmp5
- Cmp5a
- Cmp6
- Cmp6a

2000 0 2000 4000 6000 Feet

MIAMI HARBOR GENERAL REEVALUATION REPORT
Proposed Navigation Channel Modifications

N

U.S.ARMY CORPS OF ENGINEERS
Jacksonville District

Figure A-2

Manager. Facilities are leased to port users and operators. There are three principal terminal operators at the Port: Seaboard Marine, the Port of Miami Terminal Operating Company (POMTOC), and Universal Maritime/Maersk. Seaboard Marine's container terminal and storage areas are located along the southern portion of Dodge Island and the southwest corner of Lummus Island. POMTOC's container terminal is located exclusively on Lummus Island, as is Universal Maritime/Maersk's (northeastern portion). The Port's infrastructure that supports cargo and cruise ship operations is identified in **Table A-1** to **Table A-4**.

The berthing areas are identified in **Figure A-2**. The berth specifications (length, depth, berthing area, and use) are shown in **Table A-1**. Cargo supporting storage (transit sheds and open storage) and gantry cranes are displayed in **Table A-2**. The specifications for the gantry cranes are shown in **Table A-3**. As shown in **Table A-3**, currently there are three Panamax and seven Post-Panamax gantry cranes; two super-Post-Panamax gantry cranes are scheduled to arrive in 2003/2004. Panamax, Post-Panamax, and Super-Post-Panamax gantry cranes are designed to reach across 13 containers (approximately 8 feet wide), 17 containers, and 22 containers, respectively.

In addition to gantry cranes, the Port's cargo handling equipment includes forklifts, toploaders, and mobile truck cranes including three Mi-Jack 850-P Rubber Tire Gantries (RTGs), which allow containers to be stacked 6-wide and 4-high.

There are eleven passenger terminals that accommodated 3.3 million passengers in fiscal year 2000. The Port's passenger terminals are designated Terminals 1 through 5, Terminal 6/7, Terminal 8/9, Terminal 10, and Terminal 12 (see **Figure A-2**). The berth and terminal specifications are identified in **Table A-1** and **Table A-4**, respectively.

As identified in the Port's 1999 Master Plan, approximately 47.5 acres of the Port's land area is utilized by support facilities: parking, 17.0 acres; circulation and open space, 10.5 acres; office – Federal Government, 8.5; recreation, 7.5 acres; office-miscellaneous and office-Seaport Department, 1.7 acres.

CSX Transportation, Inc serves the Port of Miami. The Miami-Dade County Seaport Department owns 2.1 miles of trackage at the Port of Miami on Dodge Island, which consists of a main line track extending the length of the island and a four-track, closed-end intermodal rail yard. The main track on Dodge Island connects with the Florida East Coast Railway via a rail bridge. A connection with CSX Transportation, Inc. is effected through an interchange in the west part of the city of Miami. Moreover, the Port is less than one mile from major highways: Interstate 95 and Federal Route 1 via Interstate 395, and Interstate 75 via Dolphin and Palmetto Expressways. The Miami International Airport (MIA) is located on a 3,300-acre site about five miles northeast of downtown Miami.

There is a private petroleum facility at Fisher Island (see **Figure A-2**). This facility receives Number 6 fuel oil and diesel fuel by tankers and barges (integrated tug and barge units - ITBs). The fuel is used solely for bunkering the Port's cargo and cruise ships, which are bunkered at the berth by tank truck or by bunkering barge. This facility has an 800-foot long berth with a depth of 36 feet and 12 storage tanks having a total capacity of 667,190 barrels.

As reported in the U.S. Army Corps of Engineers' Port Series No. 16 document (revised 1999), within Metropolitan Miami and Dade County 12 companies operate warehouses having a total of over 1,000,000 square feet of dry storage space and over 6,000,000 cubic feet of cooler and freezer space. All except three of the warehouses have railroad connections, and each is accessible to arterial highways.

Anchorage for deep-draft cargo vessels lies north of the entrance channel to Miami Harbor. There are no bridges crossing the shipping channels for Dodge and Lummus Islands.

Table A-1: Specifications for Current Berths (Bays)[1]

Berth Number	Length (feet)	Depth (feet)	Berthing Area [2] (feet)	Use(s)
Bays 213, 214, 219 (Passenger Terminal 6)	750	32	125	Cruise, RO-RO [3]
Bays 1-25 3/4 (Passenger Terminals 1-5 & 10)	3,220	36	125	Cruise
Bays 25 3/4 -38	1,600	36	125	Cruise
Bays 38-45 (Passenger Terminals 8 &9)	1,680	36	125	Cruise
Bays 45-55	1,200	36	125	Cruise
Bay 55W	900	36	125	RO-RO, LO-LO [3]
Bay 59W	550	32	125	RO-RO, LO-LO
Bay 65W	690	32	125	RO-RO, LO-LO
Bays 99-140 (Gantry Crane Berths)	5,500	42	125	Container, RO-RO, LO-LO
Bays 144-148	600	25	125	RO-RO, LO-LO
Bay 154	670	25	125	RO-RO, LO-LO
Bay 155	550	25	125	RO-RO, LO-LO
Bay 165-177	1,450	25	125	RO-RO, LO-LO
Bays 183-195 (Passenger Terminal 12) [4]	1,450	25	125	Cruise

[1] Source: Port of Miami, 2000 Official Directory, page 53. Note: Ships' berths are noted with bay numbers that begin at the northwest corner of Dodge Island. Bay numbers increase in a clockwise direction around the port in increments of approximately 120 feet per bay.
[2] Linear distance perpendicular to the berth bulkhead. Based on the extreme breadth of the largest vessel using the berth, plus an amount for mooring fenders and cargo discharging equipment.
[3] Roll-On/Roll-Off; Lift-On/Lift-Off.
[4] Bay 183 is the Fisher Island Ferry Terminal.

Table A-2: Dry Cargo Facilities and Gantry Cranes

	Transit Sheds		Open Storage	Gantry Cranes	
General Location	Number	Cargo Space (Sq. Ft.)	Area (Acres)	Number	Type
Bays 213, 214, 219 (Passenger Terminal 6)					
Bays 1-25 3/4 (Passenger Terminals 1-5 & 10)	2	93,000			
Bays 25 3/4 -38					
Bays 38-45 (Passenger Terminals 8 &9)	2	288,000			
Bays 45-55	1	119,000			
Bay 55W					
Bay 59W					
Bay 65W					
Bays 99-140 (Gantry Crane Berths)			230 [4]	10	3 Panamax 7 Post-Panamax
Bays 144-148			[4]		
Bay 154	1	36,000	70 [4]		
Bay 155			[4]		
Bay 165-177	1	73,500	[4]		
Bays 183-195 (Passenger Terminal 12) [5]			[4]		

[1] Source: Port of Miami, 2000 Official Directory, page 53. Note: Ships' berths are noted with bay numbers that begin at the northwest corner of Dodge Island. Bay numbers increase in a clockwise direction around the port in increments of approximately 120 feet per bay.
[2] Linear distance perpendicular to the berth bulkhead. Based on the extreme breadth of the largest vessel using the berth, plus an amount for mooring fenders and cargo discharging equipment.
[3] Roll-On/Roll-Off; Lift-On/Lift-Off.
[4] The Port of Miami has 300 acres of open storage. Of the 300 acres, 230 acres is located on the eastern end of Lummus Island extending east to west from Bays 99 to 148. The remaining 70 acres is located on the southern end of Dodge and Lummus Islands extending from Bays 148 to 190.
[5] Bay 183 is the Fisher Island Ferry Terminal.

Table A-3: Gantry Crane Specifications			
Area	Lummus Island	Lummus Island	Lummus Island
Location (Berths)	Bays 99-140	Bays 99-140	Bays 99-140
Number	3	7	2
Type	Panamax Diesel-Electric, Traveling Gantry Crane with Hinged-Cantilevered Boom	Post-Panamax Diesel-Electric, Traveling Gantry Crane with Hinged-Cantilevered Boom	Super-Post-Panamax Electric, Traveling Crane with Hinged-Cantilevered Boom
Lift Capacity Below Spreader (Long Tons)	40	50	50
Outbound Reach (feet)	125	151	213
Back Reach (feet)	-	85	85
Maximum Clear Hoist (feet)	135	150	181
Rail Gauge (feet)	100	100	100

[1] Source: For Panamax and Post-Panamax cranes: Ports of Miami, Port Everglades, Palm Beach, and Port Canaveral, Florida, Port Series No. 16 Revised 1999, U.S. Army Corps of Engineers (NDC-99-P-4), page29. For Super-Post Panamax Cranes that are on order and scheduled for delivery in October 2002, Port Authority specification documentation.

Table A-4: Cruise Passenger Terminals

Passenger Terminal	Location	Gross Floor Area (Sq. Ft.)	Year Constructed/Significant Renovation
Terminal No. 1-5	North side of Dodge Island	17,975 (each)	1969-1970
Terminal No. 6/7	North side of Dodge Island	150,000	1971-1972
Terminal No. 8/9	North side of Dodge Island	190,000	1978/1996-1997
Terminal No. 10	North side of Dodge Island	58,000	1986
Terminal No. 12	South side of Dodge Island	66,500	1988

1 Source: Table 2.8, Cruise Passenger Terminals, 1999 Port of Miami Master Development Plan, April 30, 1999.

CARGO MOVEMENTS AND FLEET COMPOSITION

The Port of Miami handles container, trailer, neobulk (united/bundled), and breakbulk (loose non-containerized) cargo. As shown in **Table A-5**, Port Authority records for fiscal year 2000 (October 1999 to September 2000) report a total of 7,804,946 short tons of cargo. Containerized cargo, which consists of containers and trailers, represented 97.4 percent of all cargo: containers 61.8 percent, and trailers 35.6 percent. Neobulk and breakbulk cargo represented only 2.6 percent of all cargo. Cargo vessels recorded 2,424 calls, or 70.3 percent of all ship calls (3,447). The cargo is carried on container ships, Roll-On/Roll-Off (RO/RO) ships, and Lift-On/Lift-Off (LO/LO) ships. The LO/LO ships have on-board cranes, and are primarily used in the Caribbean and Latin American trade, as many of the ports in these trade areas do not have gantry cranes. The trailer cargo is containerized cargo that is carried on RO/RO ships that, except for auto carriers, carry fixed-wheel trailers on the lower decks, and often carry containers on the upper deck. Most cargo is carried on "cellular" container ships that are designed to carry only containers.

Most of the container and trailer cargo recorded at the Port is classified as general cargo, not otherwise specified (N.O.S.). Examples of individual classes are refrigerated fruits and vegetables, miscellaneous apparel, textiles, and foodstuff. Buses and trucks are examples of breakbulk cargo. Lumber is an example of neobulk cargo.

In addition to handling cargo traffic, the Port of Miami is a major homeport for 17 cruise ships belonging to Carnival Cruise Lines, Norwegian Cruise Line, and Royal Caribbean International. These companies offer 4 to 11 day cruises. As shown in **Table A-5**, 3,364,643 passengers embarked/disembarked, and 1,023 ship calls were recorded in fiscal year 2000, representing 29.7 percent of the total number of calls.

The vessels currently calling at Miami Harbor range in size from small general cargo vessels to Royal Caribbean International's VOYAGER-class cruise ships (length overall, 1,021 feet; breadth, 156 feet; draft, 28 feet). The largest dry cargo vessel class is the Panamax class of containership (length overall, 965 feet; breadth, 106 feet; draft, 44 feet). A Panamax class vessel is a vessel with dimensions that allow it to transit the Panama Canal: 950 feet long with a beam of 106 feet, except for passenger and container ships, which may have a length of 965 feet (lock dimensions are 1,000 feet long and 110 feet wide). The Panama Canal has a vessel draft restriction of 39 feet, 6 inches freshwater (equivalent to 38 feet, 8 inches saltwater).

Table A-5: Miami Harbor Waterborne Commerce Fiscal Year 2000				
Cargo	Short Tons /Passengers	Percentage Of Total Cargo Tonnage	Ship Calls	Percentage of Total Calls
Container	4,827,102	61.8%		
Trailer	2,771,475	35.6%		
Other [2]	206,369	2.6%		
Cargo Tonnage Total	7,804,946	100.0%	2,424	70.3%
Passengers	3,364,643		1,023	29.7%
Total Ship Calls			3,447	100.0%

[1] Source: State of the Port 2001, Port of Miami.
[2] Neobulk (united/bundled) and breakbulk (loose non-containerized) cargo.

PROBLEMS AND OPPORTUNITIES

Channel Widening

Channel widening measures comprise widening the seaward portion of the entrance channel from 500 feet to 800 feet (Component 1C), dredging the widener between buoys 13 and 15 (Component 2A), and widening Fisherman's Channel approximately 100 feet to the south (Component 5A). The purpose of Channel Widening is to increase safety, reduce damages, reduce delays, and avoid increases in tug assist costs for the Post-Panamax vessels that are expected to call in the future. Ships have grounded at entrance due to currents. Existing conditions allow surging that prevents cargo vessels at berth from discharging or loading cargo when a vessel passes.

In the without-project condition, as Post-Panamax vessels begin to call, grounding frequency and associated safety reduction and incurred damages will increase. Surging caused by passing vessels will worsen. The Post-Panamax vessels will require extra tug assistance.

In the with-project condition, groundings will be significantly reduced. Surging caused by passing vessels will be lessened. Post-Panamax vessels will require less tug assistance.

Benefits attributable to channel widening include: (1) reduced damages; (2) reduced delays (vessels holding until grounded vessel is removed and less interruption to discharging vessels); (3) increase in navigation safety; (4) reduced transit times; and (5) reduced tug assist costs.

Fisher Island Turning Basin Extension

The existing Fisher Island Turning Basin is not large enough for the Post-Panamax container ships that are expected to call in both the without- and with-project conditions to turn. Without the Fisher Island Turning Basin Extension (Component 3B), these vessels can turn in the previously authorized 42-foot deep Lummus Island Turning Basin, but extending the Fisher Island turning basin would provide a closer place to turn for the larger vessels. Therefore, this increment would provide more flexibility in allocating turning basin use among vessels, leading to timesaving efficiencies.

Shipping Channel, Fisher Island Turning Basin, and Lummus Island Turning Basin Deepening

Panamax and future-calling Post-Panamax container vessels arriving to or departing from Miami Harbor cannot fully load because of current channel depths. In the without-project condition, this light loading of vessels will sustain current transportation costs. Deepening the channel will allow vessels to more fully load, increasing efficiency. Benefits to deepening are reduced transportation costs resulting from the partial or full elimination of light loading.

METHODOLOGY

GENERAL

National Economic Development (NED) benefits will be assessed for the alternatives identified in the PROBLEMS/OPPORTUNITIES section following the methodology for deep draft commercial navigation analysis described in the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* and other relevant Corps of Engineers analyses and policy guidance.

Benefits equal the difference between without- and with-project transportation costs. All costs are adjusted to the base year of the project, 2010, and are then converted to Average Annual Equivalent (AAEQ) values using the Fiscal Year (FY) 2004 Federal discount rate of 5.625 percent, assuming a 50-year study period. All costs are at October 2003 price levels. The benefits estimated for the separable elements of each alternative will be compared to its cost to determine its economic justification. The plan that maximizes net benefits (benefits less cost) is the National Economic Development (NED) Plan. The NED Plan is the Federal recommended plan, and may or may not be equal to the locally preferred plan.

Specific procedures, assumptions and parameters for estimating vessel utilization savings (deepening benefits), vessel operational time savings (delay reduction benefits), and benefits during construction are discussed in the BENEFITS section of this Appendix under BENEFIT ESTIMATION PROCEDURES/ASSUMPTIONS/PARAMETERS.

Please note that the same type of summary values in the tables presented herein, for example total export short tons for 2000, may not exactly match each other due to the rounding of values and/or to values obtained from different sources. These differences are insignificant and as such do not affect the analysis.

DESIGN VESSELS

A design vessel represents the largest vessel class that is expected to call over the study period of analysis. It is important to identify the design vessel(s) so that decision makers can be reasonably confident that the significant study and project costs will result in a channel design that will accommodate vessel traffic for the foreseeable future at Miami Harbor. As previously discussed, Miami Harbor is a "clean port"; that is, it does not handle bulk cargoes or potentially dangerous or hazardous cargos such as fuel oil. Accordingly, only two types of vessels need to be considered: container ships and passenger (cruise) ships.

To identify the design vessels, the following steps were taken: (1) the world fleet and ships on order were reviewed using Lloyd's Register of Ships CD ROM., which includes ships on order through 2005; (2) future projections from companies like Clarkson's Research Studies were reviewed; and (3) cargo shipping companies and cruise ship companies were contacted to get their assessment on the largest vessels that will call at Miami Harbor in the foreseeable future.

The container ship design vessel research focused on Maersk, as (1) it is the largest container ship company in the world, (2) its fleet consists of the largest container ships in the world, (3) its vessels provide liner service at the Port of Miami, and (4) its terminal subsidiary, Universal Maritime, operates a terminal at the Port of Miami.

Maersk advised the District that the largest container ships that it would use at the Port of Miami in the near-term future are its 6,600-TEU S-Class container ships that are 1,138.4 feet long with an extreme breadth 140.8 feet and a design draft of 47.6 feet. Maersk has 18 S-Class vessels in its fleet, which are currently deployed in the Europe-Far East trade and the Far East-U.S. West Coast trade.

In 1998, Maersk tested the utilization of one of its six 6,000-TEU K-Class container ships, the REGINA MAERSK, at U.S. East Coast ports. The K-Class vessels are smaller than the S-Class ones. They have a length of 1,044.1 feet, an extreme breadth of 140.4 feet, and a design draft of 47.6 feet. The REGINA MAERSK could not call at Miami Harbor because the Port lacked a turning basin to accommodate the vessel. With the construction of the previously authorized 1,500-foot diameter Lummus Island Turning Basin in the without-project condition, Post-Panamax container ships can call at Miami Harbor, albeit light-loaded, prior to the base year of the project.

A review of the dimensions of every steamship company's in-service and on-order (through 2004) container ship fleet in Lloyd's Register of Ships demonstrated that the Maersk S-Class vessels are representative of the largest container ships in the world fleet that will call on a regular basis at Miami Harbor. Therefore, the SUSAN MAERSK was selected as the container ship design vessel.

Lloyd's Register of Ships was also reviewed for the selection of a cruise ship design vessel. Based on the review, the Royal Caribbean International's VOYAGER OF THE SEAS was selected as the design vessel for the study. It is 137,300 GRT, is 1,021 feet long, and has a beam of 156 feet and a design draft of 28.2 feet. This cruise ship, which is currently calling, is considered the largest cruise ship likely to call at Miami Harbor for the foreseeable future. Presently, Royal Caribbean International has two VOYAGER-class ships calling a Miami Harbor: the VOYAGER OF THE SEAS and the EXPLORER OF THE SEAS. The draft requirement of the design vessel does not present a problem as the Main Channel has a project depth of 36 feet. Modern cruise ships are designed with drafts that can be accommodated by the shallow depths at their ports-of-call. However, the QUEEN MARY II, which is scheduled for completion in 2003, will be 1,131 feet long with a beam of 131 feet and a design draft of 32.8 feet. Thus, the QUEEN MARY II is 110 feet longer than the VOYAGER OF THE SEAS, but its beam is 25 feet less. Because it is longer, and could potentially call, the SUSAN MAERSK container ship with a length of 1,138 feet and a beam of 141 feet was turned in the Main Channel Cruise Ship Turning Basin during the ship simulation. There were no problems with turning the large container ship.

Because of the growth in cruises, channel improvements, as well as a Dodge Island turning basin, are being considered for the Dodge Island Terminal Number 12 (south western side

of Dodge Island). In November 2001, Celebrity Cruise Lines' HORIZON began utilizing this terminal. The HORIZON is 682 feet long, with a beam of 96 feet, and a draft of 24 feet. Based on discussions with the Port, the CARNIVAL DESTINY was selected as the design vessel for this project alternative. The CARNIVAL DESTINY is 893.5 feet long, with a beam of 116, and a draft of 27 feet.
The specifications of the design vessels are summarized below:

Container ship: SUSAN MAERSK.
Length Overall: 1,138.4 feet.
Extreme Breadth: 140.8 feet.
Maximum Draft: 47.6 feet.
Cargo Capacity: 6,600 TEUs reported by Maersk (6,418 TEUs reported in Lloyd's Register of Ships).

For Berths (Bays) 213 to 219 and 1 to 50 at northwest side of Dodge Island using the Main Channel:
Cruise Ship: VOYAGER OF THE SEAS.
Length Overall: 1,020.7 feet.
Extreme Breadth: 155.5 feet.
Maximum Draft: 28.2 feet.
Passenger Capacity: 3,840.

For Berths (Bays) 183 to 195 at southwest side of Dodge Island using Fisherman's Channel:
Cruise Ship: CARNIVAL DESTINY
Length Overall: 893.5 feet.
Extreme Breadth: 116.6 feet.
Maximum Draft: 27.2 feet.
Passenger Capacity: 2,642.

BENEFITS

PORT AND INDUSTRY TRENDS

Cargo and Passengers

Historical Cargo Traffic

The direction of cargo movements for Miami Harbor for fiscal year 2000 is displayed in **Table A-6**. As reported in the Port's Performance Report (Statistical), September 2000, 57.18 percent of commodity movements were inbound (foreign imports and domestic receipts). Of all inbound movements, 89.06 percent were foreign imports. Likewise, on the outbound side, 94.72 percent were foreign exports. Thus, the origin of inbound cargo and destination of outbound cargo are mostly foreign ports. Consequently, 91.48 percent of all cargo was transported on foreign flag vessels.

As shown in **Table A-7**, historically the annual distribution of import and export tonnage has been close with import tonnage representing only slightly more. Over the 10-year period 1990 to 2000, import tonnage has averaged 52 percent of the total annual tonnage with a tight range from 49.25 percent in 1992 to 57.18 percent in 2000. Slightly higher import tonnage reflects the general U.S. trade deficit situation.

Table A-8 displays cargo traffic by trade region for fiscal year 2000. The South American trade region recorded the most tonnage with 24.18 percent of all cargo tonnage. The European trade region was a close second with 23.81 percent. The Central American and Caribbean trade regions recorded 20.48 percent and 15.47 percent, respectively. The Far East/Asia/Pacific trade represented 11.37 percent. Domestic, North American, trade represented 4.10 percent; and Middle East/South West Asia/Africa represented 0.58 percent of all tonnage in 2000. Thus, the Latin American and Caribbean trade region represented 60.14 percent of all cargo tonnage recorded at Miami Harbor. This trade region along with the European and Far East trade regions represents 95.32 percent of all tonnage handled at the Port. As shown in **Table A-8**, except for the Caribbean and South American trade regions, import tonnage exceeds export tonnage.

Historical tonnage for these three trade regions for the 10-year period 1990 to 2000 is displayed in **Table A-9**. These regions have historically represented about 96 (95.75) percent of all tonnage handled at the Port. All three regions have experienced significant positive growth for both the 10-year period as well as the 5-year period 1995 to 2000, except for the Far East region. The negative growth in the Far East trade region is due to an exceptionally high amount of tonnage in 1995, which skews the compound annual growth rate. But, in fact the tonnage for the Far East trade region has remained stable from 1994 to 2000 when excluding the tonnage recorded in 1995, varying within a tight range of 805,330 short tons in 1998 to 887,509 short tons in 2000. The European trade region has experienced the highest compound annual growth rates: 9.94 percent for the 10-year period and 14.28 percent for the 5-year period.

The list of the top ten trade countries for Fiscal Years 1992 and 2000 are compared in **Table A-10**. In 1992, the Latin American and Caribbean countries dominated with 50 percent of

Table A-6: Miami Harbor Waterborne Commerce Fiscal Year 2000

	Inbound	% of	% of	% of	**Outbound**	% of	% of	% of	**Total**	% of
U.S. Flag	(Short Tons)	U.S. Flag	Inbound	Total	(Short Tons)	U.S. Flag	Outbound	Total	(Short Tons)	Total
Containers	390,306	79.92%	8.75%	5.00%	138,690	78.66%	4.15%	1.78%	528,996	6.78%
Trailers	98,003	20.07%	2.20%	1.26%	37,562	21.30%	1.12%	0.48%	135,565	1.74%
Other	50	0.01%	0.00%	0.00%	73	0.04%	0.00%	0.00%	123	0.00%
Sub-total	488,359	100.00%	10.94%	6.26%	176,325	100.00%	5.28%	2.26%	664,684	8.52%
	Inbound	% of	% of	% of	**Outbound**	% of	% of	% of	**Total**	% of
Foreign Flag	(Short Tons)	Foreign Flag	Inbound	Total	(Short Tons)	Foreign Flag	Outbound	Total	(Short Tons)	Total
Containers	2,756,323	69.34%	61.76%	35.32%	1,541,783	48.71%	46.14%	19.75%	4,298,106	55.07%
Trailers	1,102,260	27.73%	24.70%	14.12%	1,533,650	48.45%	45.89%	19.65%	2,635,910	33.77%
Other	116,244	2.92%	2.60%	1.49%	90,002	2.84%	2.69%	1.15%	206,246	2.64%
Sub-total	3,974,827	100.00%	89.06%	50.93%	3,165,435	100.00%	94.72%	40.56%	7,140,262	91.48%
Total Inbound	4,463,186			**Total Outbound**	3,341,760			**Total**	7,804,946	
% of Total	57.18%			% of Total	42.82%					

Source: Performance Report (Statistical), Metropolitan Dade County Seaport Department, September 2000.

Table A-7: Historical Tonnage Export/Import (Short Tons)

Year	Export	% of Total	Import	% of Total	Total
1990	1,579,809	43.99%	2,011,128	56.01%	3,590,937
1991	1,886,942	48.60%	1,995,342	51.40%	3,882,284
1992	2,332,873	50.75%	2,263,608	49.25%	4,596,481
1993	2,568,576	49.41%	2,629,716	50.59%	5,198,292
1994	2,775,575	49.79%	2,798,677	50.21%	5,574,252
1995	2,778,368	47.57%	3,062,447	52.43%	5,840,815
1996	2,899,486	49.48%	2,960,052	50.52%	5,859,538
1997	3,364,124	49.95%	3,371,264	50.05%	6,735,388
1998	3,480,397	49.32%	3,576,267	50.68%	7,056,664
1999	3,190,769	46.04%	3,739,603	53.96%	6,930,372
2000	3,341,760	42.82%	4,463,186	57.18%	7,804,946
Compound Annual Growth Rate					
1990-2000	7.78%		8.30%		8.07%
1995-2000	3.76%		7.82%		5.97%
Source: Port reports.					

Table A-8: Regional Cargo Traffic By Trade Region Fiscal Year 2000 (Short Tons)

Region	Export	% of Region Total	Import	% of Region Total	Total	% of Total
Caribbean	894,252	26.76%	313,280	7.02%	1,207,532	15.47%
Central America	719,388	21.53%	879,169	19.70%	1,598,557	20.48%
Europe	344,650	10.31%	1,513,975	33.92%	1,858,625	23.81%
Far East, Asia,Pacific	278,311	8.33%	609,198	13.65%	887,509	11.37%
Middle East, SW Asia, Africa	9,042	0.27%	35,840	0.80%	44,882	0.58%
North America	78,347	2.34%	242,043	5.42%	320,390	4.10%
South America	1,017,768	30.46%	869,682	19.49%	1,887,450	24.18%
Total	3,341,758	100.00%	4,463,187	100.00%	7,804,945	100.00%
	42.82%		57.18%		100.00%	
Source: State of the Port 2001, Port of Miami.						

Table A-9: Historical Cargo Tonnage by Trade Regions (Short Tons)

Year	All Cargo	Latin America & Caribbean	% of Total	Far East	% of Total	Europe	% of Total	Total Tonnage for the Three Trade Regions	% of Total
1990	3,590,937	2,428,389	67.63%	301,781	8.40%	720,707	20.07%	3,450,877	96.10%
1991	3,882,284	2,697,312	69.48%	376,856	9.71%	660,511	17.01%	3,734,679	96.20%
1992	4,596,481	3,190,281	69.41%	538,424	11.71%	740,227	16.10%	4,468,932	97.23%
1993	5,198,292	3,635,157	69.93%	616,459	11.86%	783,031	15.06%	5,034,647	96.85%
1994	5,574,252	3,409,595	61.17%	849,510	15.24%	849,510	15.24%	5,108,615	91.65%
1995	5,840,815	3,551,551	60.81%	1,064,880	18.23%	953,711	16.33%	5,570,142	95.37%
1996	6,002,744	3,839,378	63.96%	873,678	14.55%	944,856	15.74%	5,657,912	94.26%
1997	6,735,388	4,721,323	70.10%	880,395	13.07%	1,008,924	14.98%	6,610,642	98.15%
1998	7,056,634	4,815,156	68.24%	805,330	11.41%	1,233,800	17.48%	6,854,286	97.13%
1999	6,930,372	4,296,831	62.00%	831,645	12.00%	1,455,378	21.00%	6,583,854	95.00%
2000	7,804,946	4,693,539	60.14%	887,509	11.37%	1,858,625	23.81%	7,439,673	95.32%
Compound									
Annual									
Growth									
Rate									
1990-2000	8.07%	6.81%		11.39%		9.94%		7.98%	
1995-2000	5.97%	5.73%		-3.58%		14.28%		5.96%	

Source: Port of Miami Annual Reports.

Table A-10: Top 10 Trade Countries

		FY 1992		% of	% of	FY 2000		% of	% of
Top 10 Import Countries	Rank	Country	Short Tons	Sub-total	Total	Country	Short Tons	Sub-total	Total
	1	Hong Kong	201,000	13.74%	8.88%	Spain	522,699	17.39%	11.71%
	2	Venezuela	179,000	12.24%	7.91%	Guatemala	457,372	15.22%	10.25%
	3	Honduras	165,000	11.28%	7.29%	Italy	345,302	11.49%	7.74%
	4	Colombia	165,000	11.28%	7.29%	Honduras	344,387	11.46%	7.72%
	5	Guatemala	165,000	11.28%	7.29%	Taiwan	301,107	10.02%	6.75%
	6	Italy	154,000	10.53%	6.80%	Brazil	297,073	9.89%	6.66%
	7	Japan	118,000	8.07%	5.21%	Hong Kong	241,241	8.03%	5.41%
	8	Spain	115,000	7.86%	5.08%	Belgium	178,768	5.95%	4.01%
	9	Taiwan	114,000	7.79%	5.04%	Venezuela	163,047	5.43%	3.65%
	10	Costa Rica	87,000	5.95%	3.84%	Netherlands	154,185	5.13%	3.45%
Sub-total			1,463,000	100.00%	64.63%		3,005,181	100.00%	67.33%
Total			2,263,608		100.00%		4,463,187		100.00%
Top 10 Export Countries	Rank								
	1	Venezuela	434,000	28.70%	18.60%	Dominican Republic	336,825	16.22%	10.08%
	2	Puerto Rico	186,000	12.30%	7.97%	Venezuela	311,032	14.98%	9.31%
	3	Guatemala	165,000	10.91%	7.07%	Honduras	284,979	13.73%	8.53%
	4	Jamaica	152,000	10.05%	6.52%	Guatemala	269,254	12.97%	8.06%
	5	Dominican Republic	110,000	7.28%	4.72%	Jamaica	245,373	11.82%	7.34%
	6	Honduras	109,000	7.21%	4.67%	Panama	169,305	8.15%	5.07%
	7	Panama	99,000	6.55%	4.24%	Brazil	144,738	6.97%	4.33%
	8	Chile	89,000	5.89%	3.82%	Japan	121,594	5.86%	3.64%
	9	Costa Rica	84,000	5.56%	3.60%	Costa Rica	96,648	4.66%	2.89%
	10	Spain	84,000	5.56%	3.60%	Chile	96,467	4.65%	2.89%
Sub-total			1,512,000	100.00%	64.81%		2,076,215	100.00%	62.13%
Total			2,332,873		100.00%		3,341,758		100.00%

Source: State of the Port 2001 and 1993, Port of Miami.

Table A-11: Top 10 Commodities

		FY 1992		% of	% of	FY 2000		% of	% of
Top 10 Import Commodities	Rank	Commodity	Short Tons	Sub-total	Total	Commodity	Short Tons	Sub-total	Total
	1	Refrigerated Fruit/Vegetables	320,054	32.84%	14.14%	General Cargo, N.O.S.	1,231,138	45.17%	27.58%
	2	Stone, Clay, Tile, Brick	223,352	22.92%	9.87%	Tiles, Marble & Granite	544,486	19.98%	12.20%
	3	Coffee, Tea, Spices	87,264	8.95%	3.86%	Fruits & Vegetables, Refrigerated	324,631	11.91%	7.27%
	4	Apparel/Finished Textiles	82,248	8.44%	3.63%	Apparel, Miscellaneous	185,191	6.80%	4.15%
	5	Iron/Steel/Metal	50,571	5.19%	2.23%	Lumber & Wood	95,628	3.51%	2.14%
	6	Canned/Preserved Fruit	48,558	4.98%	2.15%	Iron, Steel & Other Metal Products	77,942	2.86%	1.75%
	7	Alcoholic Beverages	46,133	4.73%	2.04%	Beverages, Alcoholic	77,423	2.84%	1.73%
	8	Seafood Refrigerated	41,287	4.24%	1.82%	Beverages, Non-Alcoholic	71,417	2.62%	1.60%
	9	Plastic & Rubber Goods	38,115	3.91%	1.68%	Coffee, Tea, Spices	63,820	2.34%	1.43%
	10	Spare Parts	36,892	3.79%	1.63%	Paper & Paper Products	53,680	1.97%	1.20%
Sub-total			974,474	100.00%	43.05%		2,725,356	100.00%	61.06%
Total			2,263,608		100.00%		4,463,187		100.00%
Top 10 Export Commodities	Rank								
	1	Paper/Newsprint	118,131	15.62%	5.06%	General Cargo, N.O.S.	1,289,256	63.70%	38.58%
	2	Spare Parts	101,001	13.36%	4.33%	Textiles	169,217	8.36%	5.06%
	3	Iron/Steel/Metal	92,485	12.23%	3.96%	Paper & Paper Products	146,603	7.24%	4.39%
	4	Textiles/Fabric/Carpet	77,200	10.21%	3.31%	Foodstuff	86,273	4.26%	2.58%
	5	Trucks & Buses	71,480	9.45%	3.06%	Building Materials	76,343	3.77%	2.28%
	6	Refrigerated Fruit/Vegetables	70,909	9.38%	3.04%	Spare Parts	61,755	3.05%	1.85%
	7	Non-Refrigerated Food Products	60,740	8.03%	2.60%	Iron, Steel & Other Metal Products	52,726	2.61%	1.58%
	8	Construction Machinery	59,085	7.81%	2.53%	Electrical Machinery Equipment	50,965	2.52%	1.53%
	9	Automobiles	55,722	7.37%	2.39%	Machinery & Industrial Equipment	45,653	2.26%	1.37%
	10	Electrical Machinery Equipment	49,349	6.53%	2.12%	Plastic & Rubber Goods	45,186	2.23%	1.35%
Sub-total			756,102	100.00%	32.41%		2,023,977	100.00%	60.57%
Total			2,332,873		100.00%		3,341,758		100.00%
Source: State of the Port 2001 and 1993, Port of Miami.									

Table A-12: Historical Number of TEUs

Year	TEUs	
1990	373,851	
1991	408,034	
1992	519,954	
1993	572,170	
1994	629,259	
1995	656,175	
1996	706,217	
1997	761,183	
1998	813,762	
1999	777,821	
2000	868,178	
Compound		
Annual		
Growth		
Rate		
1990-2000	8.79%	
1995-2000	5.76%	
Source: State of the Port reports		
and Performance Reports,		
Port of Miami.		

Table A-13: Historical Number of Passengers

Year	Passengers	
1990	2,734,816	
1991	2,928,532	
1992	3,095,487	
1993	3,157,130	
1994	2,967,081	
1995	2,974,703	
1996	3,052,450	
1997	3,191,885	
1998	2,960,264	
1999	3,112,355	
2000	3,364,643	
Compound		
Annual		
Growth		
Rate		
1990-2000	2.09%	
1995-2000	2.49%	
Source: State of the Port reports		
and Performance Reports,		
Port of Miami.		

Table A-14: Historical Import (Inbound) and Export (Outbound) Cargo Tonnage (Short Tons) - Container, Trailer, Other

	Container	Container	Container	Trailer	Trailer	Trailer	Other	Other	Other	Total	Total	
Year	Import	Export	Total	Import	Export	Total	Import	Export	Total	Import	Export	Total
1990	1,326,301	898,851	2,225,152	490,048	555,694	1,045,742	194,779	125,264	320,043	2,011,128	1,579,809	3,590,937
1991	1,252,731	1,000,262	2,252,993	575,176	751,218	1,326,394	167,435	135,462	302,897	1,995,342	1,886,942	3,882,284
1992	1,394,822	1,159,172	2,553,994	693,118	855,678	1,548,796	175,668	318,023	493,691	2,263,608	2,332,873	4,596,481
1993	1,692,653	1,275,257	2,967,910	755,036	993,893	1,748,929	182,027	299,426	481,453	2,629,716	2,568,576	5,198,292
1994	1,867,563	1,443,937	3,311,500	760,531	1,032,470	1,793,001	170,583	299,168	469,751	2,798,677	2,775,575	5,574,252
1995	2,250,544	1,523,922	3,774,466	743,096	1,031,683	1,774,779	68,807	222,763	291,570	3,062,447	2,778,368	5,840,815
1996	2,130,232	1,651,937	3,782,169	773,555	1,069,728	1,843,283	56,265	177,821	234,086	2,960,052	2,899,486	5,859,538
1997	2,393,678	1,881,294	4,274,972	915,965	1,308,289	2,224,254	61,621	174,541	236,162	3,371,264	3,364,124	6,735,388
1998	2,618,232	1,944,396	4,562,628	891,886	1,347,967	2,239,853	66,149	188,034	254,183	3,576,267	3,480,397	7,056,664
1999	2,671,115	1,683,253	4,354,368	959,449	1,384,045	2,343,494	109,039	123,471	232,510	3,739,603	3,190,769	6,930,372
2000	3,146,629	1,680,473	4,827,102	1,200,263	1,571,212	2,771,475	116,294	90,075	206,369	4,463,186	3,341,760	7,804,946
Compound												
Annual												
Growth												
Rate												
1990-2000	9.02%	6.46%	8.05%	9.37%	10.95%	10.24%	-5.03%	-3.24%	-4.29%	8.30%	7.78%	8.07%
1995-2000	6.93%	1.98%	5.04%	10.06%	8.78%	9.32%	11.07%	-16.56%	-6.68%	7.82%	3.76%	5.97%

Source: Performance Reports (Statistical), Metropolitan Dade County Seaport Department.

the top 10 import countries and 80 percent of the top 5 import countries. In 2000, there were an equal number of countries from the European and Latin American and Caribbean trade regions. This finding is consistent with the high compound annual growth rates for the European trade region displayed in **Table A-9**. From 1992 to 2000, the list of top ten export countries remained dominated by countries within the Latin American and Caribbean trade region, which accounted for 9 of the top 10 countries and all 5 of the top 5 countries. The only change is that an Asian trade region country, Japan, replaced Spain, a European trade region country.

The list of top ten commodities for Fiscal Years 1992 and 2000 are compared in **Table A-11**. The most significant difference between the two years for both imports and exports is the inclusion of the cargo category General Cargo, N.O.S. (Not Otherwise Stated) for fiscal year 2000. The amount this category represents, 45.17 percent of imports, and 63.07% of exports, which accounts for its significance. Of the "stated" commodities, the most significant is the cargo category of Tiles, Marble & Granite found under imports. It is significant because this commodity is an import from Europe (Spain and Italy), and has increased from 223,352 short tons in 1992 to 544,486 short tons in 2000, or an increase of 144 percent. The significant growth in this cargo is an individual example of the significant overall growth rate for commodities in the European trade region, as shown in **Table A-9**; as well as the increase in the number of European countries in the top 10 import countries displayed in **Table A-10**.

The historical total annual number of TEUs is displayed in **Table A-12**. Typically 70 percent are full containers. The compound annual growth rates are consistent with those for tonnage displayed in **Table A-7**: 1990 to 2000, TEUs 8.79 percent, tonnage 8.07 percent; 1995 to 2000, TEUs 5.76 percent, tonnage 5.97 percent.

Historical Cruise Ship Passengers
The historical annual number of cruise ship passengers is shown in **Table A-13** for the 10-year period 1990 to 2000. The number of cruise ship passengers has increased by 629,827 passengers, or an increase of 23 percent from 1990 to 2000. This growth results in a compound annual growth rate of 2.09 percent. Moreover, for the period 1995 to 2000, the compound annual growth rate is slightly higher, 2.49 percent.

Future Container and Trailer Cargo Traffic
As shown in **Table A-5**, container and trailer cargo represents 97.4 percent of all cargo. The remaining 2.6 percent consists of neobulk and breakbulk cargo. Historical growth rates for these commodity types are displayed in **Table A-14** for the 10-year period 1990 to 2000. Container cargo grew from 2,225,152 short tons in 1990 to 4,827,102 short tons in 2000, which represents a 117 percent increase, or a compound annual growth rate of 8.05 percent. For the 5-year period 1995 to 2000, the compound annual growth rate was about 3 percent lower (5.04 percent). This resulted from slower growth in export container trade for this period (1.98 percent). Container imports demonstrated the most growth. From 1990 to 2000, the compound annual growth rate was 9.02%, and only about 2 percent lower for the period 1995 to 2000.

The overall compound annual growth rates of 9.02 percent for imports and 6.46 percent for exports are higher than the overall world and overall United States rates. As reported in Lloyd' Register's Fairplay Market Forecast - Container (February 2000), "Containership trade expansion has nearly doubled the world growth rate in the 1990s. Loaded TEU volumes averaged just under 7 percent annual growth in the 1990s." In "U.S. Industry & Trade Outlook 2000", The McGraw-Hill Companies reported an annual growth rate in United States liner import trade of 7.5 percent and 3.6 percent for United States liner export trade for the period 1993 to 1999.

Historically, cargo growth has varied by trade region and by direction (origin/destination). It is expected that cargo will continue to grow in a similar pattern in the future; that is, the future will reflect, in part, the past, as no significant changes in the pattern of cargo traffic are anticipated without or with the project. Historical export and import tonnage by trade region is presented in **Table A-15** and **Table A-16**, respectively. Using compound average annual growth rates for exports and imports for each trade region rather than a single, composite compound average annual growth rate for all cargo traffic will result in a more accurate cargo projection by significantly reducing the uncertainty associated with using a general composite rate.

Exports: Tonnage for the Caribbean, South America, Central America and Mexico are combined into one category, Latin America and Caribbean. Cargo is shipped in both containers and trailers. At the Port of Miami, all cargo shipped in trailers is within this general trade region. As shown in **Table A-15,** export growth has been fueled by South American trade (11.59 percent) from 1990 to 2000. However, slower growth (2.12 percent) in this trade between 1995 and 2000 has offset significant average annual growth in the Caribbean and Central American and Mexico trades: 11.87 percent and 11.92 percent, respectively. The average annual rate of growth in exports to Europe is greater during the second half of the period 1990 to 2000: 9.44 percent compared to 4.68 percent, respectively. In contrast, exports to the Far East have a very high average annual growth rate (28.25 percent) for the period 1990 to 2000, but they have been positive but modest (0.47 percent) from 1995 to 2000. Exports to the Middle East/South West Asia/Africa are marginal in relative volume (9,042 short tons in 2000) and have demonstrated negative growth (-12.09 percent) from 1990 to 2000. North American exports are almost nonexistent until 1994, when there was a major single-year increase in tonnage (314,615 short tons). In contrast, the following year only 20,884 short tons were exported. From 1996 to 2000, North American exports (shipments), which include U.S. domestic and Canadian cargo, have recorded an average annual rate of growth of 3.78 percent, compared to the 28.56 percent from 1995 to 2000, which is skewed by the relatively low tonnage recorded in 1995 compared to later years. Canadian trade tonnage is only about 13.4 percent of the North American inbound trade; and 12.1 percent of all North American trade tonnage.

Table A-15: Export Cargo Tonnage by Region

Export Tonnage by Region — ***Short Tons*** [1]

Fiscal Year	Caribbean	Central America & Mexico	South America	Latin America & Caribbean Total	Europe	Far East, Asia, Pacific	Middle East, SW Asia, Africa	North America	Other	All Outbound Total	Foreign Export Total
1990	595,982	356,024	339,797	1,291,803	218,188	23,127	32,800	0	n/a	1,565,918	1,565,918
1991	544,142	443,928	598,092	1,586,162	208,866	24,706	37,964	3,714	n/a	1,861,412	1,857,698
1992	667,527	483,890	810,849	1,962,266	304,441	26,515	n/a [2]	na/	42,123	2,335,345	2,293,222
1993	840,030	511,121	883,508	2,234,659	218,480	44,733	n/a	n/a	66,295	2,564,167	2,497,872
1994	798,601	332,974	892,276	2,023,851	239,168	182,237	15,704	314,615	n/a	2,775,575	2,460,960
1995	510,278	409,580	916,503	1,836,361	219,534	271,858	38,178	20,884	n/a	2,386,815	2,365,931
1996	608,729	533,994	1,194,350	2,337,073	317,411	284,664	51,709	63,236	n/a	3,054,093	2,990,857
1997	807,328	658,682	1,534,103	3,000,113	258,335	306,604	8,768	61,751	n/a	3,635,571	3,573,820
1998	994,965	624,387	1,517,254	3,136,606	260,153	242,831	9,548	82,875	n/a	3,732,013	3,649,138
1999	1,021,046	658,575	924,366	2,603,987	232,926	261,005	14,996	77,855	n/a	3,190,769	3,112,914
2000	894,252	719,388	1,017,768	2,631,408	344,650	278,311	9,042	73,348	n/a	3,336,759	3,263,411
1990-2000	4.14%	7.29%	11.59%	7.37%	4.68%	28.25%	-12.09%			7.86%	7.62%
1995-2000	11.87%	11.92%	2.12%	7.46%	9.44%	0.47%	-25.03%	28.56%		6.93%	6.64%

[1] Source: State of the Port.

[2] n/a: not applicable, that is, no tonnage reported.

Table A-16: Import Cargo Tonnage by Region

Import Tonnage by Region — ***Short Tons*** [1]

Fiscal Year	Caribbean	Central America & Mexico	South America	Latin America & Caribbean Total	Europe	Far East, Asia, Pacific	Middle East, SW Asia, Africa	North America	Other	All Inbound Total	Foreign Import Total
1990	259,214	412,452	464,920	1,136,586	502,519	278,654	30,035	48,301	n/a	1,996,095	1,947,794
1991	212,968	383,924	514,258	1,111,150	451,645	352,150	35,452	35,040	n/a	1,985,437	1,950,397
1992	246,582	457,193	524,240	1,228,015	435,786	511,909	n/a [2]	n/a	55,148	2,230,858	2,175,710
1993	267,945	467,618	664,935	1,400,498	564,551	571,726	n/a	n/a	60,338	2,597,113	2,536,775
1994	274,176	379,373	732,195	1,385,744	529,563	667,273	70,413	145,684	n/a	2,798,677	2,652,993
1995	314,712	555,833	844,645	1,715,190	734,177	793,022	84,462	137,324	n/a	3,464,175	3,326,851
1996	268,975	568,528	664,802	1,502,305	627,445	589,014	68,438	128,499	n/a	2,915,701	2,787,202
1997	284,386	655,709	781,115	1,721,210	750,589	573,791	45,007	200,019	n/a	3,290,616	3,090,597
1998	321,919	704,512	654,119	1,680,550	973,647	562,499	35,335	215,487	n/a	3,467,518	3,252,031
1999	303,656	713,142	624,140	1,640,938	1,252,393	605,068	26,925	214,279	n/a	3,739,603	3,525,324
2000	313,280	879,169	869,682	2,062,131	1,513,975	609,198	35,840	242,043	n/a	4,463,187	4,221,144
1990-2000	1.91%	7.86%	6.46%	6.14%	11.66%	8.14%	1.78%	17.49%		8.38%	8.04%
1995-2000	-0.09%	9.60%	0.59%	3.75%	15.57%	-5.14%	-15.76%	12.00%		5.20%	4.88%

[1] Source: State of the Port.

[2] n/a: "not applicable", that is, no tonnage reported.

Imports: As shown in **Table A-16**, imports for the Latin America and Caribbean trade recorded a lower average annual growth rate than exports for the period 1990 to 2000: 6.14 percent compared to 7.37 percent. This is the result of modest (1.91 percent) annual growth in Caribbean imports from 1990 to 2000, demonstrating no growth from 1995 to 2000, and modest growth (0.59 percent) in the South America trade. In contrast, European imports were robust over the period 1990 to 2000, and even stronger between 1995 and 2000, recording average annual growth rates of 11.66 percent and 15.57 percent, respectively. Far East imports were robust between 1990 and 2000, recording an average annual growth rate of 8.14 percent. In contrast, for the period 1995 to 2000, the average annual growth rate was –5.14 percent. This is due to the highest amount of import tonnage being recorded in 1995. Using the period 1996 to 2000 results in a more accurate representation of the more recent past, showing positive but modest average annual growth (0.84 percent). Imports in the Middle East/South West Asia/Africa trade recorded a modest average annual growth rate (1.78 percent) for the period 1990 to 2000, with a negative average annual rate (-15.76 percent) for the period 1995 to 2000. North American imports (receipts), which include U.S. domestic and Canadian cargo, recorded robust average annual growth rates for both the 1990 to 2000 and 1995 to 2000 periods, 17.49 percent and 12.00 percent, respectively.

With respect to projecting future growth in cargo traffic, Corps guidance states: "Generally, specific commodity studies are of limited value for projections beyond approximately 20 years. Given this limitation, it is preferable to extend the traffic projections to the end of project life through the use of general indices on a regional and industry basis." (*Principles and Guidelines*, page 63). Historical cargo traffic trends and near-term general economic activity indicators are used to project future cargo traffic over the project life consistent with the guidance, which is intended to account for progressively greater levels of uncertainty.

National and regional economic indicators that are relevant to the general level of economic active are presented in **Table A-17**. The indicators are average annual rates of change (growth). Historical rates are shown for the period 1990 to 2000, as are near-term forecasted rates for the period 2000 to 2010. This information was obtained from various sources; for example, the estimated compound average annual growth trade for exports and imports was obtained from an article entitled "The U.S. economy to 2010" the *Monthly Labor Review*, November 2001, published by the U.S. Department of Labor.

The projected national average annual rates of change for exports and imports for 2000 to 2010, weighted per goods handled at Miami Harbor, are used as a guide to growth in export and import cargo from 2001 to 2030 (year 20 of the project life). Specifically, the values are used to set the upper boundary of the annual rate of change (growth) that any trade region will experience on average. The maximum average annual growth rate was set 7.6 percent for imports and 6 percent for exports. If the historical average annual rate of growth exceeded this rate, it would be reduced to this level. For those regions that experienced average annual growth rates less than this maximum, the historical (1990 to 2000) average annual rate of growth was used through 2030.

Using this method of setting an upper growth rate parameter that represents a national average, accounts for the distribution of future cargo traffic between U.S. East Coast ports.

Specifically, the projected future cargo traffic at Miami Harbor is less likely to include a shift of some cargo traffic from other U.S. East Coast ports.

Corps guidance recommends using "general indices on a regional and industry basis" after year 20 of the project life. The Bureau of Economic Analysis (U.S. Department of Commerce) was the main source of the long-term regional projections. However, it discontinued preparing and publishing its OBERS projections in 1996. In lieu of these projections, other general economic activity indicators were reviewed for the purpose of projecting cargo growth after year 20 of the project life: national gross domestic product (GDP), gross state product (GSP), and national, state and regional (Miami) personal income and population growth. This economic data is presented in **Table A-17**. As noted in the Table, national data was obtained from publications prepared by the Bureau of Economic Analysis, BEA, (U.S. Department of Commerce) and the Bureau of Labor Statistics, BLS, (U.S. Department of Labor); while state and regional data was obtained from the Bureau of Economic and Business Research, BEBR, (University of Florida).

Table A-17: National and Regional Economic Indicators of Cargo Exports and Imports-Average Annual Rate of Change (Growth)

National - U.S.	GDP [1]	GSP [2]	All Goods Exports [1]	Weighted per Miami Goods Exports [3]	All Goods Imports [1]	Weighted per Miami Goods Imports [3]	Personal Income [1]	
Period	(real dollars)	(real dollars)	(real dollars)	(real dollars)	(real dollars)	(real dollars)	(current dollars)	Population
1990 - 2000	3.20	3.46	7.80	5.70	10.20	9.50	5.40	1.23 [2]
2000 - 2010	3.40		8.10	6.00	8.40	7.60	5.50	0.86 [4]
2010 - 2020								0.81 [4]
2020 - 2030								0.78 [4]
2030 - 2040								0.72 [4]
2040 - 2050								0.68 [4]
2050 - 2060								0.68 [4]
Regional								
Florida								
1990 - 2000		3.72 [2]					6.28 [5]	2.11 [2]
2000 - 2010							6.45 [5]	1.66 [5]
2010 - 2020							7.01 [5]	1.45 [5]
2020 - 2030								1.19 [5]
2030 - 2040								
2040 - 2050								
2050 - 2060								
Miami PMSA								
1990 - 2000							5.31 [5]	1.54 [2]
2000 - 2010							5.71 [5]	1.46 [5]
2010 - 2020							6.53 [5]	1.14 [5]
2020 - 2030								0.96 [5]
2030 - 2040								
2040 - 2050								
2050 - 2060								

[1] Bureau of Labor Statistics, U.S. Department of Labor.
[2] Bureau of Economic Analysis, U.S. Department of Commerce.
[3] Compound average annual rates for cargo types specifically handled at the Port of Miami weighted by their relative tonnage in fiscal year 1999.
[4] U.S. Census Bureau.
[5] Bureau of Economic and Business Research, University of Florida.

Unlike bulk commodities, like coal and petroleum products, containerized cargo traffic growth does not correlate well with population growth. Commodities like coal for power generation and gasoline for vehicle use have average annual growth rates of 1 to 2 percent in large urban areas, which have similar average annual population growth rates. However, for ports serving major urban areas and hinterland markets, like Miami Harbor, historical (1990 to 2000) annual containerized cargo growth has been, on average, three times the annual population growth rates, or approximately 6 to 8 percent compared to 1 to 2 percent. For some trade regions, mainly Europe and Asia, the historical average annual growth rate for containerized has exceeded 10 percent. A small portion of the growth in containerized cargo is explained by the shipment of commodities previously shipped break bulk being shipped in containers. But, the current difference between the rate of annual population growth and containerized cargo growth is too great to use the projected annual population growth rate for the containerized cargo growth rate after year 20 of the project period.

As shown in **Table A-17**, state and regional economic indicators (GSP, personal income and population growth) have historically been equal to or slightly greater than the same national values. This is true for near-term projections of personal income and population average annual growth rates. Based on this fact, national GDP was selected as a general economic indicator of the base level of economic activity for the Port of Miami that estimates that 70 percent of all cargo handled by the Port originates or is destined for the Miami area.

Accordingly, after 2030, the national GDP for the period 2000 to 2010, or 3.4 percent, is used as a guide to projecting the average annual growth rate between 2030 and 2060. This value represents roughly one-half (50 percent) of the compound average annual growth rates set for imports (7.6 percent) and exports (6.0 percent): 44.7 and 56.6 percent, respectively. As such, one-half of the expected average annual growth rates projected for 2001 to 2030 were assumed to be the upper boundary for the average annual rate of change (growth) that any trade region would experience. For example, for a region with the maximum upper boundary import rate of 7.6 percent for the period 2001 to 2030, its upper boundary for the period 2030 to 2060, would be 3.8 percent, or slightly more (+0.4 percent) than the GDP annual rate of change (growth) in real dollars projected for 2000 to 2010. Regions with lower rates for 2001-2030 would have rates less than 3.8 percent. The maximum upper boundary export annual rate is 3 percent or slightly less (-0.4 percent) than the GDP annual rate of change (growth).

A modification of this procedure was used for North America. For North America, only about 12 percent of the cargo is Canadian. So, all North American cargo is considered U.S. domestic cargo for the analysis. Based on a review of U.S. Domestic/Miami Harbor waterborne commerce for calendar year 2000, it was determined that almost all of the goods are manufactured products (7900, not elsewhere classified). As such, the Labor Department's projected average annual rate of growth for durable goods, 4 percent, for the period 2000 to 2010 is used for the rate of growth for the period 2003 to 2030 rather than the projected export and import rates weighted for a variety of goods; and 2 percent or one-half, for the period 2030 to 2060. The Port Authority provided actual cargo tonnage and TEUs for 2001 and 2002. A summary of projected average annual rates of growth, as well as effective average annual rates of growth, by trade region is presented in **Table A-18**.

As shown in **Table A-18**, the overall average annual growth rate for all regions is 4.72 percent for the period 2002 to 2060, and 4.47 percent over the project life, 2010 to 2060.

In **Table A-19**, projected cargo traffic is displayed in TEUs. The number of TEUs handled by the Port of Miami increases from 980,743 in 2002 (actual) to 14,251,029 in 2060. Approximately 30 percent of the total TEUs are empty containers. Also shown in this table is the relative proportion (percentage) of total TEUs each trade region represents. Over the 58 years the relative proportions change due to varying projected growth rates. Latin America/Caribbean, Middle East and North America decline, while Far East and Europe increase. The increase in European and Far East trade is consistent with current and projected burgeoning market trends for countries within these general trade regions, for example, Russia and Poland, China and Vietnam. Projected short tons are displayed in **Table A-20**.

TABLE A-18: PROJECTED AND EFFECTIVE AVERAGE RATES OF GROWTH BY TRADE REGION

Last Year of Recorded Tonnage: 2002 Base Year: 2010	Projected Average Annual Rate (%)						Effective Average Annual Rate (%) for Period [1]	
	2003 to 2009		2010 to 2029		2030 to 2060		2002 to 2060	2010 to 2060
Trade Region	Import Cargo	Export Cargo	Import Cargo	Export Cargo	Import Cargo	Export Cargo	All Cargo	All Cargo
Latin America/Caribbean	6.14	6.00	6.14	6.00	3.07	3.00	4.43	4.17
Far East	7.60	6.00	7.60	6.00	3.80	3.00	5.26	4.97
Europe	7.60	4.68	7.60	4.68	3.80	2.34	5.28	5.00
Middle East/Africa	1.78	0.00	1.78	0.00	0.89	0.00	0.99	0.95
North America (Domestic/Canadian)	4.00	4.00	4.00	4.00	2.00	2.00	2.93	2.76
All Regions							4.72	4.47

[1] Effective average annual rate (%): Resultant compound average annual rate using projected average annual rates for imports and exports for each trade region.

Table A-19: Summary of Projected TEUs by Trade Region from 2002 to 2060

Year	Latin America & Caribbean TEUs Full	Container TEUs Full	Trailer TEUs Full	TEUs Empty	Container TEUs Empty	Trailer TEUs Empty	Far East (Asian) TEUs Full	TEUs Empty	Europe TEUs Full	TEUs Empty	Middle East TEUs Full	TEUs Empty	North America TEUs Full	TEUs Empty	All Regions TEUs Full	TEUs Empty	Total TEUs
2002	417,609	129,459	288,150	178,975	55,482	123,493	85,592	36,682	153,749	65,892	15,096	6,470	14,475	6,204	686,521	294,223	980,743
2003	442,918	137,305	305,614	189,822	58,845	130,977	91,673	39,288	164,522	70,510	15,281	6,549	15,054	6,452	729,449	312,621	1,042,069
2004	469,762	145,626	324,136	201,326	62,411	138,915	98,190	42,081	176,072	75,459	15,470	6,630	15,656	6,710	775,150	332,207	1,107,357
2005	498,233	154,452	343,781	213,528	66,194	147,334	105,176	45,075	188,455	80,766	15,662	6,712	16,282	6,978	823,808	353,060	1,176,868
2006	528,430	163,813	364,616	226,470	70,206	156,264	112,663	48,284	201,732	86,457	15,857	6,796	16,934	7,257	875,616	375,264	1,250,879
2007	560,456	173,742	386,715	240,195	74,461	165,735	120,690	51,724	215,970	92,558	16,056	6,881	17,611	7,548	930,783	398,907	1,329,689
2008	594,425	184,272	410,153	254,753	78,973	175,780	129,294	55,412	231,238	99,102	16,259	6,968	18,315	7,849	989,531	424,084	1,413,615
2009	630,452	195,440	435,012	270,193	83,760	186,433	138,518	59,365	247,613	106,120	16,465	7,056	19,048	8,163	1,052,096	450,898	1,502,994
2010	668,663	207,286	461,378	286,570	88,837	197,733	148,407	63,603	265,176	113,647	16,675	7,146	19,810	8,490	1,118,731	479,456	1,598,187
2011	709,191	219,849	489,341	303,939	94,221	209,718	159,010	68,147	284,016	121,721	16,888	7,238	20,602	8,830	1,189,706	509,874	1,699,580
2012	752,175	233,174	519,000	322,360	99,932	222,429	170,377	73,019	304,226	130,382	17,105	7,331	21,426	9,183	1,265,309	542,275	1,807,584
2013	797,764	247,307	550,457	341,899	105,989	235,910	182,565	78,242	325,907	139,674	17,326	7,426	22,283	9,550	1,345,846	576,791	1,922,637
2014	846,118	262,296	583,821	362,621	112,413	250,209	195,634	83,843	349,169	149,644	17,552	7,522	23,175	9,932	1,431,647	613,562	2,045,209
2015	897,402	278,195	619,207	384,600	119,226	265,374	209,648	89,849	374,128	160,340	17,781	7,620	24,102	10,329	1,523,061	652,740	2,175,800
2016	951,795	295,056	656,739	407,912	126,453	281,459	224,676	96,290	400,910	171,818	18,014	7,720	25,066	10,742	1,620,461	694,483	2,314,943
2017	1,009,486	312,941	696,545	432,636	134,117	298,519	240,792	103,196	429,650	184,136	18,251	7,822	26,068	11,172	1,724,247	738,962	2,463,210
2018	1,070,673	331,909	738,765	458,860	142,246	316,613	258,075	110,603	460,494	197,354	18,493	7,925	27,111	11,619	1,834,846	786,362	2,621,207
2019	1,135,570	352,027	783,543	486,672	150,868	335,804	276,610	118,547	493,597	211,541	18,739	8,031	28,196	12,084	1,952,711	836,875	2,789,587
2020	1,204,401	373,364	831,037	516,171	160,013	356,158	296,489	127,067	529,127	226,769	18,989	8,138	29,323	12,567	2,078,330	890,712	2,969,042
2021	1,277,405	395,996	881,410	547,459	169,712	377,747	317,810	136,204	567,265	243,113	19,244	8,247	30,496	13,070	2,212,220	948,093	3,160,314
2022	1,354,834	419,999	934,836	580,643	179,999	400,644	340,679	146,005	608,204	260,659	19,503	8,358	31,716	13,593	2,354,937	1,009,258	3,364,195
2023	1,436,958	445,457	991,501	615,838	190,910	424,929	365,210	156,518	652,153	279,494	19,767	8,471	32,985	14,136	2,507,072	1,074,458	3,581,530
2024	1,524,060	472,459	1,051,601	653,168	202,482	450,686	391,522	167,795	699,335	299,715	20,035	8,587	34,304	14,702	2,669,257	1,143,966	3,813,223
2025	1,616,442	501,097	1,115,345	692,760	214,756	478,005	419,748	179,892	749,992	321,425	20,309	8,704	35,676	15,290	2,842,167	1,218,070	4,060,237
2026	1,714,425	531,472	1,182,953	734,753	227,773	506,979	450,027	192,869	804,382	344,735	20,587	8,823	37,103	15,901	3,026,525	1,297,081	4,323,605
2027	1,818,348	563,688	1,254,660	779,291	241,580	537,711	482,511	206,790	862,784	369,764	20,870	8,944	38,588	16,538	3,223,100	1,381,327	4,604,427
2028	1,928,571	597,857	1,330,714	826,530	256,224	570,306	517,359	221,725	925,496	396,641	21,158	9,068	40,131	17,199	3,432,716	1,471,162	4,903,878
2029	2,045,477	634,098	1,411,379	876,632	271,756	604,876	554,747	237,749	992,841	425,503	21,451	9,193	41,736	17,887	3,656,253	1,566,964	5,223,216
2030	2,107,474	653,317	1,454,157	903,202	279,993	623,209	574,804	246,344	1,029,002	441,000	21,601	9,257	42,571	18,245	3,775,451	1,618,049	5,393,500
2031	2,171,350	673,118	1,498,231	930,577	288,479	642,098	595,592	255,254	1,066,501	457,071	21,751	9,322	43,423	18,610	3,898,616	1,670,834	5,569,450
2032	2,237,162	693,520	1,543,642	958,783	297,223	661,560	617,139	264,488	1,105,387	473,737	21,903	9,387	44,291	18,982	4,025,882	1,725,376	5,751,258
2033	2,304,969	714,540	1,590,429	987,843	306,231	681,612	639,471	274,059	1,145,713	491,019	22,056	9,453	45,177	19,361	4,157,386	1,781,735	5,939,121
2034	2,374,832	736,198	1,638,634	1,017,784	315,513	702,271	662,619	283,979	1,187,531	508,941	22,211	9,519	46,080	19,749	4,293,273	1,839,972	6,133,246
2035	2,446,812	758,512	1,688,300	1,048,633	325,076	723,557	686,612	294,262	1,230,899	527,527	22,367	9,586	47,002	20,144	4,433,692	1,900,152	6,333,844
2036	2,520,974	781,502	1,739,472	1,080,417	334,929	745,487	711,481	304,920	1,275,873	546,802	22,524	9,653	47,942	20,547	4,578,795	1,962,339	6,541,134
2037	2,597,385	805,189	1,792,196	1,113,164	345,081	768,083	737,259	315,968	1,322,514	566,791	22,683	9,721	48,901	20,957	4,728,742	2,026,602	6,755,344
2038	2,676,112	829,595	1,846,517	1,146,904	355,540	791,364	763,978	327,419	1,370,885	587,521	22,844	9,790	49,879	21,377	4,883,697	2,093,011	6,976,708
2039	2,757,225	854,740	1,902,485	1,181,667	366,317	815,350	791,673	339,288	1,421,049	609,021	23,005	9,859	50,876	21,804	5,043,829	2,161,639	7,205,468
2040	2,840,798	880,647	1,960,150	1,217,483	377,420	840,064	820,381	351,592	1,473,075	631,317	23,168	9,929	51,894	22,240	5,209,316	2,232,562	7,441,878
2041	2,926,903	907,340	2,019,563	1,254,386	388,860	865,526	850,139	364,345	1,527,031	654,441	23,333	10,000	52,932	22,685	5,380,338	2,305,857	7,686,195
2042	3,015,619	934,842	2,080,777	1,292,407	400,646	891,761	880,985	377,564	1,582,991	678,424	23,499	10,071	53,990	23,139	5,557,084	2,381,605	7,938,689
2043	3,107,025	963,178	2,143,847	1,331,581	412,790	918,791	912,959	391,268	1,641,028	703,297	23,666	10,143	55,070	23,602	5,739,748	2,459,890	8,199,638
2044	3,201,201	992,372	2,208,829	1,371,942	425,302	946,640	946,103	405,472	1,701,222	729,094	23,835	10,215	56,172	24,074	5,928,532	2,540,797	8,469,329
2045	3,298,232	1,022,452	2,275,780	1,413,527	438,193	975,333	980,460	420,197	1,763,652	755,850	24,006	10,288	57,295	24,555	6,123,645	2,624,417	8,748,061
2046	3,398,205	1,053,443	2,344,761	1,456,372	451,475	1,004,897	1,016,075	435,460	1,828,402	783,600	24,178	10,362	58,441	25,046	6,325,301	2,710,840	9,036,141
2047	3,501,208	1,085,375	2,415,834	1,500,516	465,160	1,035,356	1,052,994	451,283	1,895,560	812,382	24,351	10,436	59,610	25,547	6,533,723	2,800,164	9,333,888
2048	3,607,334	1,118,274	2,489,060	1,545,999	479,260	1,066,739	1,091,265	467,684	1,965,216	842,235	24,526	10,511	60,802	26,058	6,749,143	2,892,487	9,641,630
2049	3,716,677	1,152,170	2,564,507	1,592,860	493,787	1,099,073	1,130,938	484,687	2,037,463	873,198	24,703	10,587	62,018	26,579	6,971,799	2,987,911	9,959,710
2050	3,829,335	1,187,094	2,642,241	1,641,142	508,754	1,132,388	1,172,065	502,313	2,112,399	905,313	24,881	10,663	63,258	27,111	7,201,938	3,086,542	10,288,480
2051	3,945,408	1,223,077	2,722,332	1,690,888	524,175	1,166,712	1,214,699	520,585	2,190,124	938,623	25,061	10,740	64,524	27,653	7,439,815	3,188,489	10,628,305
2052	4,065,000	1,260,150	2,804,850	1,742,141	540,064	1,202,077	1,258,896	539,526	2,270,742	973,174	25,242	10,818	65,814	28,206	7,685,695	3,293,866	10,979,562
2053	4,188,218	1,298,348	2,889,870	1,794,949	556,434	1,238,515	1,304,714	559,163	2,354,364	1,009,012	25,425	10,897	67,130	28,770	7,939,851	3,402,790	11,342,641
2054	4,315,171	1,337,703	2,977,468	1,849,357	573,301	1,276,056	1,352,213	579,519	2,441,100	1,046,185	25,610	10,976	68,473	29,346	8,202,566	3,515,382	11,717,949
2055	4,445,972	1,378,251	3,067,721	1,905,415	590,679	1,314,736	1,401,453	600,622	2,531,069	1,084,743	25,796	11,056	69,842	29,932	8,474,133	3,631,768	12,105,901
2056	4,580,739	1,420,029	3,160,710	1,963,172	608,583	1,354,589	1,452,501	622,500	2,624,391	1,124,738	25,984	11,136	71,239	30,531	8,754,855	3,752,077	12,506,932
2057	4,719,592	1,463,074	3,256,519	2,022,680	627,031	1,395,649	1,505,422	645,180	2,721,193	1,166,224	26,174	11,217	72,664	31,142	9,045,045	3,876,444	12,921,489
2058	4,862,654	1,507,423	3,355,231	2,083,993	646,038	1,437,955	1,560,286	668,694	2,821,604	1,209,258	26,365	11,299	74,117	31,765	9,345,027	4,005,008	13,350,035
2059	5,010,054	1,553,117	3,456,937	2,147,164	665,621	1,481,543	1,617,165	693,070	2,925,761	1,253,896	26,558	11,382	75,600	32,400	9,655,138	4,137,912	13,793,050
2060	5,161,922	1,600,196	3,561,726	2,212,250	685,797	1,526,452	1,676,133	718,342	3,033,805	1,300,201	26,753	11,465	77,112	33,048	9,975,723	4,275,306	14,251,029
2060	**Total**					7,374,171		2,394,475		4,334,005		38,218		110,159			14,251,029
	% of Total					51.74%		16.80%		30.41%		0.27%		0.77%			100.00%
2002	**Total**					596,584		122,275		219,641		21,565		20,678			980,743
	% of Total					60.83%		12.47%		22.40%		2.20%		2.11%			100.00%

Notes: (1) 2002 is latest complete fiscal year of reported cargo from Port records.
(2) 2010 is the Base Year of the study period. (3) Approximately 12 short tons (12.33) overall per full TEU.

Table A-20: Summary of Total Short Tons by Trade Region from 2000 to 2060

Year	Latin America & Caribbean Total Short Tons	Far East (Asian) Total Short Tons	Europe Total Short Tons	Middle East Total Short Tons	North America Total Short Tons	All Regions Total Short Tons
2000	4,693,539	887,509	1,858,625	44,882	320,391	7,804,946
2001	5,072,892	954,163	1,817,706	62,981	339,262	8,247,004
2002	5,281,079	1,082,402	1,944,306	190,899	183,049	8,681,735
2003	5,601,144	1,159,296	2,080,549	193,243	190,371	9,224,603
2004	5,940,609	1,241,712	2,226,607	195,630	197,986	9,802,543
2005	6,300,651	1,330,050	2,383,201	198,058	205,905	10,417,865
2006	6,682,516	1,424,739	2,551,105	200,530	214,141	11,073,032
2007	7,087,528	1,526,242	2,731,151	203,046	222,707	11,770,674
2008	7,517,091	1,635,051	2,924,233	205,607	231,615	12,513,598
2009	7,972,692	1,751,700	3,131,311	208,213	240,880	13,304,796
2010	8,455,910	1,876,757	3,353,418	210,866	250,515	14,147,465
2011	8,968,419	2,010,833	3,591,661	213,566	260,536	15,045,015
2012	9,511,995	2,154,586	3,847,234	216,314	270,957	16,001,087
2013	10,088,522	2,308,721	4,121,416	219,111	281,796	17,019,565
2014	10,699,997	2,473,992	4,415,584	221,957	293,067	18,104,598
2015	11,348,538	2,651,213	4,731,217	224,855	304,790	19,260,613
2016	12,036,394	2,841,254	5,069,904	227,804	316,982	20,492,337
2017	12,765,948	3,045,051	5,433,354	230,805	329,661	21,804,819
2018	13,539,727	3,263,609	5,823,402	233,860	342,847	23,203,446
2019	14,360,414	3,498,005	6,242,024	236,969	356,561	24,693,973
2020	15,230,851	3,749,397	6,691,339	240,134	370,824	26,282,545
2021	16,154,056	4,019,027	7,173,629	243,354	385,657	27,975,723
2022	17,133,227	4,308,230	7,691,344	246,633	401,083	29,780,517
2023	18,171,759	4,618,437	8,247,120	249,969	417,126	31,704,411
2024	19,273,249	4,951,187	8,843,788	253,365	433,811	33,755,400
2025	20,441,515	5,308,132	9,484,393	256,821	451,164	35,942,025
2026	21,680,606	5,691,043	10,172,210	260,339	469,210	38,273,408
2027	22,994,816	6,101,825	10,910,756	263,920	487,979	40,759,296
2028	24,388,700	6,542,522	11,703,815	267,564	507,498	43,410,099
2029	25,867,089	7,015,329	12,555,454	271,273	527,798	46,236,944
2030	26,651,098	7,268,967	13,012,751	273,161	538,354	47,744,330
2031	27,458,872	7,531,855	13,486,961	275,065	549,121	49,301,873
2032	28,291,132	7,804,332	13,978,716	276,987	560,103	50,911,271
2033	29,148,621	8,086,752	14,488,673	278,925	571,305	52,574,276
2034	30,032,104	8,379,479	15,017,511	280,881	582,731	54,292,706
2035	30,942,368	8,682,893	15,565,936	282,854	594,386	56,068,437
2036	31,880,225	8,997,386	16,134,682	284,844	606,274	57,903,411
2037	32,846,513	9,323,366	16,724,507	286,853	618,399	59,799,638
2038	33,842,092	9,661,256	17,336,200	288,879	630,767	61,759,195
2039	34,867,852	10,011,494	17,970,580	290,923	643,382	63,784,232
2040	35,924,707	10,374,534	18,628,495	292,986	656,250	65,876,972
2041	37,013,599	10,750,848	19,310,827	295,067	669,375	68,039,716
2042	38,135,500	11,140,924	20,018,490	297,166	682,763	70,274,843
2043	39,291,412	11,545,270	20,752,432	299,284	696,418	72,584,815
2044	40,482,364	11,964,410	21,513,637	301,421	710,346	74,972,178
2045	41,709,420	12,398,890	22,303,128	303,577	724,553	77,439,568
2046	42,973,674	12,849,275	23,121,963	305,752	739,044	79,989,708
2047	44,276,253	13,316,152	23,971,243	307,946	753,825	82,625,420
2048	45,618,321	13,800,128	24,852,109	310,160	768,902	85,349,620
2049	47,001,073	14,301,835	25,765,744	312,394	784,280	88,165,326
2050	48,425,745	14,821,925	26,713,378	314,647	799,965	91,075,660
2051	49,893,605	15,361,077	27,696,287	316,921	815,965	94,083,854
2052	51,405,965	15,919,994	28,715,792	319,215	832,284	97,193,250
2053	52,964,173	16,499,407	29,773,267	321,529	848,930	100,407,305
2054	54,569,619	17,100,070	30,870,137	323,864	865,908	103,729,598
2055	56,223,736	17,722,769	32,007,880	326,220	883,226	107,163,832
2056	57,927,999	18,368,318	33,188,032	328,596	900,891	110,713,836
2057	59,683,929	19,037,560	34,412,183	330,994	918,909	114,383,575
2058	61,493,092	19,731,371	35,681,986	333,413	937,287	118,177,149
2059	63,357,103	20,450,658	36,999,156	335,854	956,033	122,098,803
2060	65,277,624	21,196,363	38,365,471	338,316	975,153	126,152,927
Average Annual Rate of Growth	**4.43%**	**5.26%**	**5.28%**	**0.99%**	**2.93%**	**4.72%**

Notes: (1) 2002 is latest complete fiscal year of reported cargo from Port records.
(2) 2010 is the Base Year of the study period.

Future Neobulk and Breakbulk Cargo Traffic
As shown in **Table A-5**, neobulk and breakbulk ("Other") cargo represent 2 to 3 percent of all tonnage handled at the Port. Lumber, steel reinforcing bars, and paper are examples of this type of cargo. As shown in **Table A-14**, these commodity types have experienced overall negative growth: 1990 to 2000, -4.29 percent; 1995 to 2000, -6.68 percent. However, imports for the period 1995 to 2000 had a positive compound annual growth rate, 11.07 percent. Many of these commodities are dependent on construction activity, which is dependent on population growth and the general level of business activity and expansion. As such, it is anticipated that future compound annual growth rate for neobulk and breakbulk cargo will be between 1 and 2 percent for imports, while no growth is predicted for exports. Because neobulk cargo and breakbulk cargo represent such a small portion of the overall cargo handled at the Port of Miami, they have an insignificant impact on current and future cargo and vessel traffic at the Port. Accordingly, for the analysis, neobulk cargo and breakbulk cargo are not analyzed separately, but are accounted for by including them in containerized cargo. Specifically, tonnage associated with these cargo types is accounted for in the projected future TEUs displayed in **Table A-19**. This is a reasonable simplification as more and more neobulk and breakbulk cargos are being shipped in containers. It should be noted that this procedure does not impact deepening benefits, as this cargo is not transported on draft-constrained vessels. However, vessels carrying this cargo would be part of the calculations for vessel delay reduction benefits.

Future Cruise Ship Passengers
It is assumed for this analysis that the compound annual growth rate for cruise ship passengers will be 2 percent, the same as the historical compound annual growth rate for the 10-year period, 1990 to 2000, displayed in Table A-13.

<u>Fleet</u>

Container Ships (Containerized Cargo)

Current Trade Routes and Vessel Itineraries

The trade routes and vessel itineraries were reviewed to identify general patterns for the container ships calling at Miami Harbor. For the European, Mediterranean, and Asian trade regions, the overall general itinerary pattern is that Miami Harbor is part of an itinerary in which it is not the originating port, nor is it the first or the last port of call. This pattern is generally true for the U.S. ports within the itineraries, but there are exceptions where Miami Harbor is the first, or the last U.S. port of call. The container ships are mainly foreign-flag, Panamax size, with a cargo capacity of 2,500- to 4,500-TEUs. These general vessel itineraries are generally applicable to the Latin American and Caribbean trade routes. However, in contrast to the European, Mediterranean, and Asian trade routes, Miami Harbor is the port of origin within the itinerary. The container ships are also mainly foreign-flag, but are smaller in size than those on the European, Mediterranean, and Asian trade routes. The maximum cargo capacity is 3,700 TEUs. Moreover, all cargo handled at the Port of Miami that is carried on Roll-on/Roll-off (Ro-Ro) vessels is traded within the Latin American and Caribbean regions.

European export cargo destined for the United States east coast ports is usually carried on container ships that typically call first at Halifax, Canada, or New York/New Jersey, United States. These container ships then call at ports along the U.S. east coast discharging import cargo and loading export cargo. With respect to Miami's position in the itinerary, at this time Charleston is typically the prior port of call. After calling at Miami, the itineraries vary.

If Gulf service is included, vessels call at New Orleans and/or Houston, then call at Freeport (Freeport Container Terminal, Grand Bahamas Island), or call at a U.S. East Coast port (Charleston or Savannah), from which they transit back to Europe with U.S. containerized cargo. Alternatively, after departing Miami, the container ships sail to U.S. Gulf ports (New Orleans and/or Houston), then call at ports in Mexico, like Vera Cruz or Alta Mira, then call at Freeport or a U.S. East Coast port prior to returning to Europe with U.S. and Latin American containerized cargo.

If Gulf service is not involved, the container ships tend to go from Miami directly to Europe or to Freeport, and then return to Europe.

In some cases, after calling at Miami, the container ships will call at Manzanillo International Terminal at Cristobal, Panama (Atlantic side of the Panama Canal). In this case, the itinerary is a world all-water itinerary in which European, U.S., and Latin American containerized cargo is shipped on the westbound transit and Asian, U.S., and Latin American containerized cargo is shipped on the eastbound transit. In this itinerary, for the westbound transit, the vessel sails from Europe to U.S. East Coast ports, then calls at Manzanillo International Terminal prior to transiting the Panama Canal. After transiting the canal, the vessel typically calls at Manzanillo, Mexico, before calling at a U.S. West Coast port, such as Long Beach. From the U.S. West port, the container ship sails to Asian ports at which it loads cargo prior to sailing east to U.S. West Coast ports. It then sails to Manzanillo, Mexico, transits the Panama Canal, then calls at U.S. East Coast Ports prior to returning to Europe.

Except for vessels that transit the Panama Canal, the only potential constraint to the efficient utilization of Post-Panamax container ships would be the depth at United States East Coast ports.

Container ships in the Mediterranean/United States East Coast Container Trade have itineraries that are similar to the itineraries in the European/United States East Coast Container Trade. There is one significant difference. Some of the Mediterranean itineraries are actually part of an Asia/Mediterranean/United States East Coast itinerary, which includes transiting the Suez Canal.

Since the vessels in the Mediterranean/U.S. East Coast trade do not transit the Panama Canal and since the Suez Canal has a maximum vessel draft of 56 feet, the only potential constraint to the efficient utilization of Post-Panamax container ships would be the depth at United States East Coast ports.

Asian containerized cargo arrives at United States East Coast ports on container ships that have either transited the Panama Canal or the Suez Canal. Container ships transiting the Suez Canal typically stop at Mediterranean ports; then continue on to United States East Coast ports (Asia/Mediterranean/United States East Coast itinerary). The alternative itinerary includes transiting the Panama Canal, where Miami Harbor is often the first U.S. East Coast port-of-call. Currently, container ships using the Panama Canal are limited in size to Panamax vessels. Without canal improvements, the only way to currently use Post-Panamax container ships is to transship cargo at the port of Balboa on the Pacific side of the canal, and/or transship cargo at the Manzanillo International Terminal on the Atlantic side. Containers would be transferred from the Post-Panamax container ships to either smaller vessels that can transit the canal or rail cars for land transshipment. However, there are plans to modify the locks and channel to accommodate Post-Panamax vessels. If funding is provided and an engineering solution is developed for expanding the fresh water supply required for the operation of the larger locks, it is estimated that the Panama Canal could be capable of handling Post-Panamax vessels by 2010.

Latin American and Caribbean trade represents a significant portion of Miami Harbor's cargo activity. Latin American trade includes ports in Mexico, Central and South America. The vessel itineraries in this trade form a pattern that is similar to those in the European, Mediterranean, and Asian trade routes, except that in some itineraries, Miami Harbor is the originating port. The typical pattern is for the container ships to combine calls at various U.S. East Coast ports and Latin American and/or Caribbean ports. Most often, a shipping company will have a separate itinerary for the west and east coasts of South America. The itineraries that involve the west coast of South America include a transit through the Panama Canal. Because of the relatively shallow harbor depths and the absence of landside gantry cranes at ports in Latin America and the Caribbean, the container ships usually have onboard cranes for cargo handling. Moreover, because of the site conditions at the ports and the onboard cranes, the container ships are smaller than those used in the European, Mediterranean, and Asian trade routes. Furthermore, the lack of landside gantry cranes is also the reason for the extensive use of Roll-on/Roll-off (RoRo) vessels, which carry trailers, as well as containers.

Trends

There are three containerized cargo industry trends: (1) the formation of partnerships among the shipping companies to share vessels to reduce available container slots on certain trade routes to increase rates, which have been depressed by excess capacity; (2) shipping companies consolidating their operations at a single port to reduce administrative and logistical costs; and (3) utilization of larger container ships to reduce unit transportation costs.

Shipping companies have been forming alliances and partnerships. For example, there is the Grand Alliance that includes NYK Line, Hapag-Lloyd, P&O Nedlloyd, and Orient Overseas Container Line (OOCL); the New World Alliance consists of Mitsui O.S.K. Lines, Neptune Orient Lines, and Hyundai Merchant Marine; the MSC-ACL that includes Mediterranean Shipping Company and Atlantic Container Line; and Cosco-Yang Ming-"K" Line that consists of China Ocean Shipping Company, Yang Ming Line, and Kawasaki Kisen Kaisha. The alliance between Maersk and Sealand worked so well that the companies merged.

In the partnerships, or alliances, the shipping companies operate under a Vessel Sharing Agreement (VSA). Under a VSA, the total number of container slots is distributed among the steamship companies. Each company pays for a fixed number of container slots. Thus, the cost of the container slots is the same whether full or empty containers are carried. These VSAs are designed to reduce the number of vessels deployed in a given trade region. The reduction in the number of available container slots increases rates, as the supply of slots is more in line with the demand for them.

Some shipping companies have been consolidating their operations at a single port to reduce administrative and logistical costs. A shipping company's announcement that it intends to develop a hub port generates keen competition among ports due to the long-term revenues generated by this business, even though significant infrastructure expenditures are usually required. For example, after months of negotiations, Maersk Sealand selected the port of New York/New Jersey as its North American East Coast hub in May 1999, disappointing the other final candidates: the ports of Baltimore, and Halifax, Canada.

The current world cellular container ship fleet and cellular container ships on order are displayed in **Table A-21** and **Table A-22**, respectively. To illustrate the trend toward the utilization of larger containerships, as of April 2001, 5000+ TEU container ships represented 4.01 percent of the world fleet; yet they represented almost 24.62 percent of the container ships on order. Moreover, there are no 7000+ TEU container ships in the world fleet, but there are six on order. It is anticipated that this trend toward the utilization of larger container ships will continue, and as such, the container ships deployed in the Atlantic trade will likewise increase in size. Hence, it is anticipated that in the future larger containerships will call at Miami Harbor; specifically, the current Panamax container ships will be replaced by Post-Panamax container ships.

As shown in **Table A-21** and **Table A-22**, there are 105 Post-Panamax (5000+TEU) container ships in the world cellular (containers only) containership fleet; and 82 are on order. There are 37 6000+ TEU container ships in the world fleet. Of the 37, Maersk Sealand owns and operates 21, which until recently were solely employed in the Europe-Asia trade, transiting the Suez Canal. In August 2002, Maersk Sealand began using SUSAN MAERSK-size (S-class) Post-Panamax container ships in an Asian/U.S. West Coast itinerary, calling at its new terminal at the Port of Los Angeles. The other 16 6000+ TEU container ships are owned and operated by companies like P&O Nedlloyd and Hapag-Lloyd. There are 44 6000+ TEU container ships on order. Even larger TEU container ships are anticipated: "Experts believe that ship sizes between 10000- and 12000-TEU can be anticipated in the future, although practical considerations seem to preclude an advance in the medium-term to drafts greater than 50 feet or 15.3 meters" (New Dimension for Hapag-Lloyd, Maritime Reporter/Engineering News, May 2001). Based on this trend toward larger container ships, Maersk Sealand's SUSAN MAERSK was selected for the design vessel for the economic analysis. The SUSAN MAERSK has 1,138-foot length over all (LOA), a maximum beam of 140.8 feet, and a maximum design draft of 47.6 feet. It has a beam that is approximately 35 feet greater than the current Maersk Sealand container ships calling at Miami Harbor.

As the larger container ships are deployed in a trade route, they replace the existing smaller ones, which are deployed in another trade route. The largest container ships are deployed in the East-West Atlantic and Pacific trades. As larger container ships replace those deployed in the East-West Atlantic and Pacific trades, the now smaller container ships are deployed in the North-South Atlantic trade, for example. An industry expert from one of the major shipping companies said in an interview that based on his company's container ship class development history, he expects 10000 TEU container ships to be deployed between Europe and a U.S. hub port by 2004. Drewry Shipping Consultants predict that 12000 TEU container ships will inter the East-West trade "during the later part of this decade (2008/2009), once the ports/terminal operating companies have made the necessary investments in new equipment, berths, etc to handle them" (Post-Panamax Containerships – The Next Generation, Drewry Insight, August 2001).

Given that so many Post-Panamax container ships are being built, it is assumed that Post-Panamax container ships will be deployed on the East-West Atlantic trade route, with calls at select "hub" U.S. East-Coast ports, before the base year (2010) of the Miami Harbor project; it is also assumed that some itineraries will include calls at select "non-hub" U.S. ports in the North-South trade. Based on current itineraries and the volume of cargo traffic at Miami Harbor, it is reasonable to assume that Miami Harbor will be part of the initial transition from Panamax to Post-Panamax container ships. Accordingly, it is assumed for this analysis that the Panamax container ships currently calling at Miami Harbor as part of the European, Mediterranean, and Asian trade will be gradually replaced by Post-Panamax container ships over the study period beginning prior to the base year (2010) of the study.

Containerized cargo in the U.S. East Coast/Far East trade can be transported by way of the Panama Canal or the Suez Canal. Because Post-Panamax container ships are too large to transit the Panama Canal, they would use the Suez Canal, which is the most cost effective alternative transportation route. For Post-Panamax container ships to use the Panama Canal route, the locks would have to be enlarged or transshipment at ports at each end of the Panama Canal would have to be used. Specifically, cargo would have to be transshipped at ports on the Atlantic and Pacific side of the Canal, Manzanillo and Balboa, respectively, if the size of the canal locks were not increased. The ports of Manzanillo and Balboa, Panama, have been developed for transshipment. Both have harbor depths and equipment to handle Post-Panamax container ships. For example, Manzanillo International Terminal currently has an access channel depth of 46 feet and six Post-Panamax rail mounted gantry cranes.

Most containerized cargo imported from Asia arrives at U.S. West Coast ports, such as Long Beach and Oakland, and is transshipped by rail or truck to various cities, including U.S. East Coast ones. The reason is time. For goods that are time sensitive in the market, such as clothing, transportation time is important. It takes about 5 days for goods to be shipped by rail from Los Angeles to Baltimore, while it takes roughly 13 days for the goods to be shipped via the Panama Canal.

However, the all-water route via the Panama Canal is less expensive than the intermodal (ship-rail/truck) route. For some shippers, price is taking charge over just-in-time inventory. Several developments have or are taking place that demonstrate that the Panama Canal is going to be a viable economic option for future containerized cargo transportation, including the utilization of Post-Panamax container ships.

The Panama Canal Commission is spending $1 billion to widen the Gaillard Cut, improve the locks and purchase more tugboats and electrical locomotives to pull the ships through the canal. This will increase the canal's capacity 20 percent by 2005.

Feasibility studies are to be completed by the end of 2002 for conceptual design of a new set of locks that would accommodate the next generation of Post-Panamax ships. If all goes smoothly, the canal authority expects its Post-Panamax locks to operate in 2010 (Agustin Arias, canal capacity project manager, Panama's Canal Holds Visions of New Growth, Waterway's new transportation and development projects to build legacy and economic future, by Aileen Cho in Panama, ENR, 7/30/2001).

A joint venture of Kansas City Southern and Mi-Jack Products has rebuilt the Panama Canal Railway. The railway parallels the canal connecting Cristobal on the Atlantic side and Balboa on the Pacific side. The 47.6-mile railway began service in November 2001. The two companies operate it under a contract with a 25-year renewal clause. The Panama Canal Railway is currently providing intermodal service for major steamship companies. Initially, the company expects to carry 75,000 containers a year between Cristobal and Balboa.

Major port management and steamship companies are investing in the port infrastructures at Balboa and Cristobal. Hutchinson Port Holdings Group, Hong Kong, won a 25-year concession contract in 1997 to operate Balboa and Cristobal ports. It has invested $140-million in cargo handling equipment, dredging, and landside improvements. Most of the investment ($110 million) is for Balboa. The channel and berths have been dredged to 42 feet (12.9 meters), and a new 20.7-acre (8.4-hectare) container storage area equipped with three Post-Panamax and six Panamax gantry cranes has nearly doubled port capacity to some 900,000 TEUs.

On the Atlantic side, Colon Container Terminal SA, a subsidiary of Evergreen Marine Corp., Taiwan, has invested $110 million in developing a marine terminal at Cristobal. The investments in cranes, expanded quay and container yard area are designed to increase the facility's capacity to about 1 million TEUs a year.

The Manzanillo International Terminal (MIT) at Cristobal on the Atlantic side, operated by Seattle-based Stevedores of America, has a channel depth of 46 feet, 6 Post-Panamax and 2 super Post-Panamax cranes for handling containers on the largest container ships in the world. It also has direct access to the Colon Free Zone (CFZ), which is the second-largest free zone after Hong Kong. The local operator of the Manzanillo International Terminal is looking at a possible second container terminal on the Pacific side, near Balboa.

In the future, it appears that the current three trade routes (ship-rail/truck, all-water via the Panama Canal and the Suez Canal) are viable options for the utilization of Post-Panamax container ships. However, based on discussions with shipping companies, the most likely use of Post-Panamax container ships is the all-water trade route using the Suez Canal. Although transshipment at the Panama Canal is possible for the U.S. East Coast/Far East trade, shippers felt that this option is less likely due to high transshipment costs. Moreover, due to the high cost to modify the Panama Canal locks and no clear source for the funds, they felt that modifying the locks to accommodate Post-Panamax container ships is highly unlikely for the foreseeable future. Thus, the analysis assumes that Panamax container ships will be transitioned to Post-Panamax container ships in the Suez Canal route only. Moreover, it is also assumed that the Panama Canal will continue to be used for the Far East trade during the study period. Thus, both canal routes are assumed to be utilized for the economic analysis: Panamax container ships using the Panama Canal and Post-Panamax container ships using the Suez Canal.

The only thing that is physically preventing the deployment of Post-Panamax container ships at Miami Harbor is an adequate size turning basin. The Lummus Island Turning Basin has been authorized, funded, and will be constructed prior to the base year. Its 1,500-foot radius is sufficient for turning the Post-Panamax container ship design vessel SUSAN MAERSK. The Ship Simulation verified this. Thus, it is assumed that Post-Panamax container ships will call in the without-project condition, prior to the base year. The depth of the Lummus Island Turning Basin will be commensurate with the existing project channel depth, 42 feet.

Roll-On/Roll-Off (Ro-Ro) Vessels (Trailer cargo)

As shown in **Table A-5** about 36 percent of all cargo tonnage (short tons) handled at the Port is transported in trailers. The trailers are carried on Ro-Ro vessels, which also carry a few containers. Lloyd's Register of Ships classifies 887 vessels as Ro-Ro Cargo Ships. The largest of these vessels have deadweights that range for 38,000 to 48,000 metric tons with design drafts that range from 35.4 feet to 40.2 feet, and container capacities that range from 2,025 to 2,833 TEUs. The typical draft is 38 feet. Lloyd's also has seven vessels classified as Container Ro-Ro Cargo Ships. The deadweight of the five largest ones is 51,648 metric tons; these vessels' design drafts are 38 feet, and their container capacity is 2,908 TEUs. With a project depth of 42 feet, these vessels have sufficient depth. It is anticipated that the current project depth at Miami Harbor will provide sufficient transit depth for Ro-Ro vessels in the future.

Cruise Ships (Passengers)

In the mid-1990s the largest cruise ship in terms of gross registered tons (GRT) was the QUEEN ELIZABETH II with 70,327 GRT. Today, 16 cruise ships have GRTs in excess of 70,000. Cunard's QUEEN MARY II, which is scheduled for completion in 2003, will be 150,000 GRT. Because of the trend toward larger cruise ships, the Royal Caribbean International's VOYAGER OF THE SEAS was selected as the design vessel for the study. It is 137,300 GRT, is 1,021 feet long, and has a beam of 156 feet and a design draft of 28.2 feet. This cruise ship, which is currently calling, is considered the largest cruise ship likely to call at Miami Harbor for the foreseeable future. Presently, Royal Caribbean International has two VOYAGER-class ships calling a Miami Harbor: the VOYAGER OF THE SEAS and the EXPLORER OF THE SEAS. The draft requirement of the design vessel does not present a problem. Modern cruise ships are designed with drafts that can be accommodated by the shallow depths at their ports-of-call. Even the QUEEN MARY II will have a design draft of only 32.8 feet. However, the QUEEN MARY II will be 1,131 feet long with a beam of 131 feet. Thus, the QUEEN MARY II is 110 feet longer than the VOYAGER OF THE SEAS, but its beam is 25 feet less. Because it is longer, and could potentially call, the SUSAN MAERSK container ship with a length of 1,138 feet and a beam of 141 feet was turned in the Main Channel Cruise Ship Turning Basin during the ship simulation. There were no problems with turning the large container ship.

Because of the growth in cruises, channel improvements, as well as the Dodge Island turning basin, are being considered for the Dodge Island Terminal Number 12 (south western side of Dodge Island). Starting in November 2001, Celebrity Cruise Lines' HORIZON will utilize this terminal. The HORIZON is 682 feet long, with a beam of 96 feet, and a draft of 24 feet. The design vessel for this project alternative is the CARNIVAL DESTINY, which is 893.5 feet long, with a beam of 116, and a draft of 27 feet.

Benefiting Fleet and Cargo

All vessels will benefit from proposed improvements that enhance vessel maneuverability, reduced transit times, and tug assists. But not all vessels and the cargo they carry will benefit from proposed deepening of the existing channel. The first step in identifying the beneficiaries of deepening the channel consisted of a review of the existing fleet calling at specific terminals. **Table A-21** shows the vessel types and their characteristics at the three general berthing areas within the Port. Also shown are the number of recorded calls and the range of the recorded static drafts (draft at dock) of the vessels that called in FY1999. This information was provided by the Biscayne Bay Pilots.

Table A-21: Existing Cargo Vessel Calls and Short Tons by Berth Areas FY 1999

Bay (Berth)	Location	Vessel Types	Vessel Size LOA Range (feet)	Maximum Design Draft (feet)	Recorded Static Draft Range at Berth FY 1999 (feet)	Total Number of Calls FY 1999 [1]	% of Total Calls	Total Short Tons FY 1999 [2]	% of Total Cargo
45 - 65W	Northwest Lummus Island	RO/RO & LO/LO	125 - 648	39.4	7 - 35.1	103	3.9%	259,354	3.7%
99 - 148	Southern Lummus Island	Container	266 - 965	44	9 - 40.3	1,644	61.5%	4,344,386	62.7%
	(Gantry Crane Berths)	RO/RO & LO/LO							
149 - 177	Southern Dodge Island	RO/RO & LO/LO	129 - 560	25.4	9.8 - 23.9	924	34.6%	2,326,632	33.6%
					Total	2,671		6,930,372	

[1] Source: Developed from daily Pilots Logs for FY 1999.
[2] Source: Developed from two separate monthly Miami-Dade Seaport Department reports for FY 1999: Trailer/Container Activity Report, and Daily Dock Report.

Roll-On/Roll-Off (Ro-Ro) and Lift-On/Lift-Off (Lo-Lo) vessels call at all three of the berthing areas, but are concentrated at Berths 45 to 65W located on the northwest side of Lummus Island on the Main Channel (36 feet deep) and Berths 149 to 177 located on the southern side of Dodge Island on the Fisherman's Channel (32 to 42 feet deep). Taking into consideration the design drafts of the vessels and the existing channel depths, vessels calling at these berths have sufficient channel depth. In contrast, the container ships calling at Berths 99 to 148 have design drafts up to 44 feet compared to the 42-foot Fisherman's Channel depth. Thus, depending on their typical loadings and underkeel clearance requirements, some of the large Panamax container ships could potentially benefit from deepening the shipping channel. Almost two-thirds of all vessels call at Berths 99 to 148, which have the Port's gantry cranes. A more detailed breakdown by vessel size (length overall, LOA) of the recorded static drafts for vessels that called at the "gantry-crane berths" (99 to 148) in FY 1999 is displayed in **Table A-22**.

One hundred percent of the containerized cargo handled at Berths 45 to 65W and 149 to 177 is moving in the Latin American and Caribbean trade. Berths 99 to 148 also handle cargo moving in these trade regions, some of which is transported in trailers. All European, Mediterranean, and Asian trade cargo is handled at the gantry-crane berths. No cargo within these trades is shipped by trailer. The larger Panamax container ships are currently utilized in these trades, and Post-Panamax container ships will only be used in these trades.

Thus, the channel-deepening benefit analysis focuses solely on containerized cargo moving in the European, Mediterranean and Asian trades, which will be solely handled at the gantry-crane berths (99 to 148), as the vessels in these trades are cellular container ships, that is, they do not have on-board cranes like those used in the Latin American and Caribbean trades due to the lack off gantry cranes at the ports.

With a channel depth of 42 feet at Miami Harbor, and assuming a minimum of 3 feet of underkeel clearance, a fully loaded Atlantic Class (=>950-foot LOA) container ship would have a light-loaded transit draft of 39 feet. As shown in Table A-22, the majority of these vessels had static (at dock) drafts ranging from 34 to 38 feet inbound, and 32 to 38 feet outbound, during 1999, but static drafts up to 41 feet were recorded. The typical static draft beyond 38 feet occurred for the range 38.1 to 39 feet.

Asian cargo currently transits the Panama Canal, which has a maximum draft restriction of 39 feet. Thus, vessels in this trade route would be expected to have a maximum transit draft of 36 feet, assuming 3 feet of underkeel clearance. For the European and Mediterranean trade routes, the depths of the U.S. East Coast ports would control inbound and outbound vessel drafts within itineraries that included Miami Harbor. The static drafts shown in **Table A-22** were recorded in 1999. At that time, U.S. East Coast ports had authorized depths ranging from 40 to 42 feet. Thus, the expected fully, but light, loaded transit draft would be between 37 to 39 feet, assuming 3 feet of underkeel clearance. As shown in **Table A-22**, many Atlantic Class vessels recorded the calculated maximum drafts. But, there were several calls with recorded static drafts between 32 and 35 feet. Therefore, some vessels arrived or departed Miami Harbor with transit drafts that were 1 to 3 feet less than their potential maximum transit drafts. This fact was taken into consideration when developing the "typical or most likely" applied maximum transit drafts of benefiting Panamax and Post-Panamax container ship classes. See Fully-Loaded Transit Weight and Applied Maximum Transit Draft section and **Table A-33** for detailed fleet transit specifications.

Five classes of container ships were established for the analysis: three classes of Post-Panamax, one class of Panamax, and one Sub-Panamax container ship class. The three Post-Panamax classes are based on the world fleet that includes ships in service and those on order as displayed in **Table A-23** and **Table A-24**. A detailed description of the composite vessel in each class is found in **Table A-33**.

Based on the previously described vessel itineraries, generic vessel itineraries were developed for the purpose of estimated voyage costs for the European, Mediterranean and Asian trades. There are two itineraries for the Asian/U.S. East Coast trade: Panama Canal and Suez Canal itineraries. The Post-Panamax container ships would be utilized solely in the Suez Canal itinerary as only Panamax-size container ships can transit the Panama Canal.

The generic itineraries are based on a review of current ones. The depths are displayed for both the without- and with-project conditions. All major U.S. East Coast ports are either authorized for construction to 50 feet, like New York; or being studied with draft reports proposing depths ranging from 48 to 50 feet, like Norfolk Harbor for which a 50-foot channel is recommended. Construction schedules have completion dates ranging from before to after the base year of the Miami Harbor project (2010).

A 50-foot channel depth has been authorized for New York/New Jersey Harbor with all channel construction completed in 2016, but all berthing areas deepened to 50 feet by 2005. Deepening the container-ship berths to 50 feet in 2005, significantly before all channel deepening to 50 feet is completed, demonstrates that tide will be used to increase the loading efficiency of the large container ships. Based on discussions with steamship companies, future itineraries that include Post-Panamax container ships will include the Port of New York/New Jersey due to the enormous hinterland market that it serves.

The December 2002 Draft Norfolk Harbor (Hampton Roads) Report recommends deepening the inbound channel to 50 feet by 2005. The outbound channel is already 50 feet deep. Thus, it is reasonable to assume that one or more of the major U.S. East Coast ports will be deepened to a depth of 50 feet with others ranging in depth from 48 to 50 feet by around the base year of the Miami Harbor project. Accordingly, for the economic analysis the midpoint of the anticipated range is assumed for the controlling depth at U.S. East Coast ports within the trade itineraries, or 49 feet. The prevalent port depth at European and Far East ports is 15 meters or 49.2 feet. Thus, selecting 49 feet for a controlling depth for U.S. East Coast ports is consistent foreign ports within the trade itineraries.

The itineraries are displayed in **Table A-25**.

These general assumptions and parameters were utilized to focus the detailed benefits analysis, which is contained in the following section: BENEFIT ESTIMATION PROCEDURES/ASSUMPTIONS/PARAMETERS.

Table A-22: Static Vessel Drafts at Gantry Berths by Length Overall (LOA)

Vessel LOA (feet)		Static Vessel Draft at Gantry Crane Berths for Each Transit per Call (feet) * (MLLW) >42	41.1 - 42	40.1 - 41	39.1 - 40	38.1 - 39	37.1 - 38	36.1 - 37	35.1 - 36	34.1 - 35	33.1 - 34	32.1 - 33	31.1 - 32	30.1 - 31	29.1 - 30	<=29	Total Transits
>=951	Inbound	0	0	1	1	7	14	38	19	16	3	0	0	0	0	0	99
	Outbound	0	0	0	2	8	16	14	8	8	15	17	9	2	0	0	99
	Total	0	0	1	3	15	30	52	27	24	18	17	9	2	0	0	198
901 - 950	Inbound	0	0	0	0	0	3	8	11	2	1	2	0	0	0	0	27
	Outbound	0	0	0	0	0	0	2	3	3	7	7	4	0	1	0	27
	Total	0	0	0	0	0	3	10	14	5	8	9	4	0	1	0	54
851 - 900	Inbound	0	0	0	0	0	0	0	1	3	4	2	1	0	0	0	11
	Outbound	0	0	0	0	0	0	0	1	2	4	4	0	0	0	0	11
	Total	0	0	0	0	0	0	0	2	5	8	6	1	0	0	0	22
801 - 850	Inbound	0	0	0	1	2	2	3	12	10	14	11	8	5	6	5	79
	Outbound	0	0	0	0	0	3	3	6	1	8	11	16	6	10	12	76
	Total	0	0	0	1	2	5	6	18	11	22	22	24	11	16	17	155
751 - 800	Inbound	0	0	0	0	1	2	0	1	4	1	3	1	3	2	0	18
	Outbound	0	0	0	0	0	1	1	2	0	1	0	1	3	3	3	15
	Total	0	0	0	0	1	3	1	3	4	2	3	2	6	5	3	33
701 - 750	Inbound	0	0	0	0	4	2	4	1	1	5	2	5	1	0	3	28
	Outbound	0	0	0	0	0	1	3	3	0	5	4	4	4	1	3	28
	Total	0	0	0	0	4	3	7	4	1	10	6	9	5	1	6	56
651 - 700	Inbound	0	0	0	0	3	3	3	9	5	15	19	25	25	18	74	199
	Outbound	0	0	0	0	0	0	0	0	6	14	26	25	28	23	77	199
	Total	0	0	0	0	3	3	3	9	11	29	45	50	53	41	151	398
601 - 650	Inbound	0	0	0	0	0	0	0	2	2	1	6	8	8	14	49	90
	Outbound	0	0	0	0	0	0	0	0	1	3	7	4	8	18	48	89
	Total	0	0	0	0	0	0	0	2	3	4	13	12	16	32	97	179
551 - 600	Inbound	0	0	0	0	0	0	0	0	4	3	8	7	13	40	163	238
	Outbound	0	0	0	0	0	0	0	2	3	0	13	17	10	37	154	236
	Total	0	0	0	0	0	0	0	2	7	3	21	24	23	77	317	474
501 - 550	Inbound	0	0	0	0	0	0	0	0	0	0	1	7	8	8	83	107
	Outbound	0	0	0	0	0	0	0	0	0	0	2	9	7	18	68	104
	Total	0	0	0	0	0	0	0	0	0	0	3	16	15	26	151	211
451 - 500	Inbound	0	0	0	0	0	0	0	0	0	0	0	0	0	1	132	133
	Outbound	0	0	0	0	0	0	0	0	0	0	0	0	0	2	128	130
	Total	0	0	0	0	0	0	0	0	0	0	0	0	0	3	260	263
401 - 450	Inbound	0	0	0	0	0	0	0	0	0	0	0	0	0	1	111	112
	Outbound	0	0	0	0	0	0	0	0	0	0	0	0	0	1	109	110
	Total	0	0	0	0	0	0	0	0	0	0	0	0	0	2	220	222
351 - 400	Inbound	0	0	0	0	0	0	0	0	0	0	0	0	0	0	117	117
	Outbound	0	0	0	0	0	0	0	0	0	0	0	0	0	0	115	115
	Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	232	232
301 - 350	Inbound	0	0	0	0	0	0	0	0	0	0	0	0	0	0	173	173
	Outbound	0	0	0	0	0	0	0	0	0	0	0	0	0	0	176	176
	Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	349	349
250 - 300	Inbound	0	0	0	0	0	0	0	0	0	0	0	0	0	0	214	214
	Outbound	0	0	0	0	0	0	0	0	0	0	0	0	0	0	215	215
	Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	429	429
	All Inbound	0	0	1	2	17	26	56	56	47	47	54	62	63	90	1124	1645
	All Outbound	0	0	0	2	8	21	23	25	24	57	91	89	68	114	1108	1630
	All Total	0	0	1	4	25	47	79	81	71	104	145	151	131	204	2232	3275

* Source: Biscayne Bay Pilots Logs for FY 1999. Note: Odd number of calls is due to the outbound or inbound transit occurring prior to or after the fiscal year.

Table A-23: World Container Ship Fleet April 2001[1]

TEU Capacity Range[2]	Total Number of Containerships	Number of U.S. Flag	Average TEU Capacity	Average Gross Registered Tons[3]	Average Net Registered Tons[4]	Average Deadweight (Metric Tons)[5]	Average Length Overall (Feet)	Average Length Between Perpendiculars (Feet)	Average Extreme Breadth (Feet)	Average Maximum Draft (Feet)	Average Speed (Knots)[6]	Average Date of Build	% of Total Containerships
7000-7499	0	0											0.00%
6500-6999	5	0	6,696	80,884	48,436	87,351	983.9	932.5	140.5	45.9	24.5	1,999	0.19%
6000-6499	32	0	6,349	84,086	44,128	93,250	1,070.2	1,021.3	137.4	46.8	24.9	1,998	1.22%
5500-5999	35	0	5,614	66,247	34,431	66,657	912.3	867.8	131.5	44.7	25.6	1,999	1.34%
5000-5499	33	0	5,283	66,751	32,437	66,285	918.7	871.1	133.3	44.6	24.9	1,998	1.26%
4500-4999	66	13	4,725	57,350	26,624	64,664	952.1	911.1	113.2	43.4	23.3	1,995	2.53%
4000-4499	99	5	4,189	51,077	27,578	58,931	940.3	891.4	108.8	42.5	24.0	1,995	3.79%
3500-3999	96	4	3,766	46,012	22,338	51,103	891.6	848.6	105.8	40.7	23.4	1,993	3.67%
3000-3499	137	7	3,239	40,336	18,339	45,138	821.3	774.8	105.8	39.2	21.9	1,992	5.24%
2500-2999	178	12	2,746	36,439	16,430	40,775	760.9	716.6	105.1	38.8	21.5	1,989	6.81%
2000-2499	231	10	2,247	29,264	12,521	33,724	685.0	644.7	101.2	37.3	20.3	1,991	8.84%
1500-1999	362	17	1,699	21,026	9,845	25,507	614.9	575.9	92.2	34.1	19.7	1,992	13.85%
1000-1499	464	16	1,190	15,820	7,276	18,957	560.2	523.8	84.6	30.8	18.6	1,990	17.76%
500-999	471	2	718	9,350	4,470	11,397	457.3	424.3	71.5	26.4	16.8	1,990	18.03%
<500	404	0	301	4,359	2,055	5,479	351.8	324.4	57.0	20.0	14.5	1,985	15.46%
Total	2,613	86											100.00%

[1] Source: Lloyd's Register of Ships CD ROM (April 2001). Includes only fully containerized ships. Not included are general cargo ships and Roll-On/Roll-Off vessels that also carry containers.
[2] TEU: Twenty-Foot Equivalent Unit. Container 20 feet long, and approximately 8 feet high and wide.
[3] Gross Tonnage is the capacity in cubic feet of the spaces within the hull, and of the enclosed spaces above the deck available for cargo, stores, fuel, passengers and crew, divided by 100. Thus, 100 cubic feet of capacity is equivalent to 1 gross ton.
[4] .Net tonnage is derived by deducting from gross tonnage spaces used for the accommodation of master, officers, crew, navigation, and propelling machinery.
[5] Deadweight is the weight in metric tons of cargo, stores, fuel, passengers and crew carried by the ship when loaded to her maximum summer loadline.
[6] Knot: 1 nautical mile per hour = 1.151 statute miles per hour. One nautical mile = 6,076 feet; and one statute mile = 5,280 feet.

Table A-24: Container Ships On Order April 2001[1]

TEU Capacity Range [2]	Total Number of Containerships	Number of U.S. Flag	Average TEU Capacity	Average Gross Registered Tons [3]	Average Net Registered Tons [4]	Average Deadweight (Metric Tons) [5]	Average Length Overall (Feet)	Average Length Between Perpendiculars (Feet)	Average Extreme Breadth (Feet)	Average Maximum Draft (Feet)	Average Speed (Knots) [6]	Average Date of Build	% of Total Containerships
7000-7499	6	0	7,267	86,333	NA	99,833	1,053.1	1,010.5	140.4	47.6	NA	2002	1.80%
6500-6999	9	0	6,643	74,656	NA	79,400	984.4	938.9	134.5	45.5	NA	2001	2.70%
6000-6499	29	0	6,293	76,163	46,427	80,322	1,003.0	979.3	135.4	45.2	NA	2002	8.71%
5500-5999	32	0	5,611	66,434	24,167	65,247	912.1	866.0	131.6	44.6	NA	2002	9.61%
5000-5499	6	0	5,283	65,500	NA	69,229	918.6	NA	130.6	NA	NA	2002	1.80%
4500-4999	6	0	4,800	55,000	NA	62,740	964.6	NA	105.6	44.3	NA	2002	1.80%
4000-4499	51	0	4,207	45,644	21,568	53,522	900.3	853.4	105.8	41.4	NA	2002	15.32%
3500-3999	9	0	3,713	39,900	NA	50,200	844.0	804.6	105.6	41.0	NA	2001	2.70%
3000-3499	20	0	3,140	33,795	14,350	40,395	727.0	689.0	105.9	39.3	NA	2002	6.01%
2500-2999	45	1	2,615	27,379	13,107	33,514	686.1	642.3	102.6	36.9	NA	2002	13.51%
2000-2499	37	0	2,423	25,907	11,997	32,433	973.2	631.3	98.1	36.3	NA	2002	11.11%
1500-1999	23	0	1,683	17,543	8,192	22,394	607.6	566.1	86.8	31.5	NA	2002	6.91%
1000-1499	31	0	1,172	12,816	5,378	15,993	515.5	484.2	80.7	29.9	NA	2002	9.31%
500-999	26	0	792	9,719	2,873	10,188	428.4	405.4	72.7	26.3	NA	2002	7.81%
<500	3	0	391	3,760	1,731	5,327	NA	NA	NA	NA	NA	2001	0.90%
Total	334	1											100.00%

[1] Source: Lloyd's Register of Ships CD ROM (April 2001). Includes only fully containerized ships. Not included are general cargo ships and Roll-On/Roll-Off vessels that also carry containers. Not all ship characteristics are available at this time. Those that are not available are noted with NA.
[2] TEU: Twenty-Foot Equivalent Unit. Container 20 feet long, and approximately 8 feet high and wide.
[3] Gross Tonnage is the capacity in cubic feet of the spaces within the hull, and of the enclosed spaces above the deck available for cargo, stores, fuel, passengers and crew, divided by 100. Thus, 100 cubic feet of capacity is equivalent to 1 gross ton.
[4].Net tonnage is derived by deducting from gross tonnage spaces used for the accommodation of master, officers, crew, navigation, and propelling machinery.
[5] Deadweight is the weight in metric tons of cargo, stores, fuel, passengers and crew carried by the ship when loaded to her maximum summer loadline.
[6] Knot: 1 nautical mile per hour = 1.151 statute miles per hour. One nautical mile = 6,076 feet; and one statute mile = 5,280 feet.

Table A-25: Miami Harbor – Generic Round-trip Vessel Itineraries by Trade Route

Trade Route	Ports in Generic Itinerary [1]	Without-Project Depth (feet) [2]	With-Project Depth (feet) [4]	Mean Tide Range (feet) [5]	Round-trip Nautical Miles [6]
Europe/	Southampton, England	49.2	49.2	5.9	
U.S. East Coast	New York, U.S. [3]	50.0	50.0	4.6	3,169
	Other East Coast, U.S. [3]	48.0 to 50.0	48.0 to 50.0	5.2	600
	Miami, U.S.	42.0	43.0 to 50.0	2.5	420
	Southampton, England	49.2	49.2	5.9	3,866
					8,055
Mediterranean/	Valletta, Malta	50.6	50.6	1.3	
U.S. East Coast	New York, U.S.	50.0	50.0	4.6	4,181
	Other East Coast, U.S.	48.0 to 50.0	48.0 to 50.0	5.2	600
	Miami, U.S.	42.0	43.0 to 50.0	2.5	420
	Valletta, Malta	50.6	50.6	1.3	4,786
					9,987
Asia/					
U.S. East Coast	Hong Kong, China	49.2	49.2	8.2	
Panama Canal	*Panama Canal transit*	39.0	39.0	n.a.	
	Miami, U.S.	42.0	43.0 to 50.0	2.5	10,448
	Other East Coast, U.S.	48.0 to 50.0	48.0 to 50.0	5.2	420
	New York, U.S.	50.0	50.0	4.6	600
	Panama Canal transit	39.0	39.0	n.a.	
	Hong Kong, China	49.2	49.2	8.2	11,213
					22,681
Asia/					
U.S. East Coast	Hong Kong, China	49.2	49.2	8.2	
Suez Canal	*Suez Canal transit*	56.0	56.0	n.a.	
	Valletta, Malta	50.6	50.6	1.3	7,435
	Miami, U.S.	42.0	43.0 to 50.0	2.5	4,786
	Other East Coast, U.S.	48.0 to 50.0	48.0 to 50.0	5.2	420
	New York, U.S.	50.0	50.0	4.6	600
	Valletta, Malta	50.6	50.6	1.3	4,181
	Suez Canal transit	56.0	56.0	n.a.	
	Hong Kong, China	49.2	49.2	8.2	7,435
					24,857

[1] Generic trade-route vessel itineraries based on actual ones as published by steamship companies.

[2] Without-project channel depths are the same as the current channel depths, except for those ports with on-going or most likely future deepening construction projects (see footnote 3).

[3] A 50-foot channel depth has been authorized for New York/New Jersey Harbor with all channel construction completed in 2016, but all berthing areas deepened to 50 feet by 2005. Other U.S. East Coast ports (Norfolk, Charleston, Savannah, for example), are studying deepening to depths up to 50 feet. The December 2002 Norfolk Harbor (Hampton Roads) report recommends deepening the inbound channel to 50 feet by 2005. The outbound channel is already 50 feet. It is anticipated that other East Coast ports will be deepened to a project depth of 48 to 50 feet between 2006 and 2010.

[4] With-project channel depths under consideration for Miami Harbor are 43 to 50 feet. All other channel depths for ports and canals within the vessel itinerary remain the same as those in the without-project condition.

[5] "Tides and Tidal Datums in the United States," Special Report No. 7, U.S. Army Corps of Engineers, February 1981; and "Lloyd's Ports of the World," Lloyd's of London, 1997.

[6] "Distances Between Ports," Defense Mapping Agency Hydrographic/Topographic Center, 1993.

BENEFIT ESTIMATION PROCEDURES/ASSUMPTIONS/PARAMETERS

Cost Reduction Benefits

Benefits Analysis

This section describes the analyses performed in the estimation of cost reduction benefits for proposed channel improvements. The objectives of the proposed channel improvement alternatives include the reduction of transit times and costs for vessels maneuvering within Miami Harbor. Nearly all users of Miami Harbor will benefit from proposed improvements inasmuch as they enhance vessel maneuverability and reduce transit times and necessary tug assists. The paragraphs that follow describe key inputs and assumptions of the analysis and present estimated cost reduction benefits. And, as will be discussed in subsequent sections, additional benefits will accrue to select vessel classes with deepening improvements.

The benefits of channel improvements were estimated in terms of reductions in harbor transit times and consequent vessel delays. Transit times and transportation costs were estimated by analyzing the most likely condition in the absence of an improved channel at Miami Harbor, that is the without project condition, and the proposed channel improvement alternatives for each decade over the period 2010-2060. For this analysis, the alternatives were bundled to estimate cost reduction benefits. The following describes briefly the proposed channel improvement alternatives: widening the entrance channel, inner entrance channel between buoys 13 and 15, and the Fisherman's Channel to provide safe navigation for all vessels, particularly post-Panamax containerships; widening the Fisher Island turning basin to improve vessel access and reduce delays; extending the Dodge Island Channel to provide access to planned expanded cruise facilities; and constructing a turning basin at Dodge Island to accommodate the cruise ships using the channel. Five component sets, each comprising an individual component or several inseparable components, representing the without project condition and four channel improvement scenarios were analyzed:

Without Project Condition - Maintain existing channels; construct Lummus Island turning basin to a diameter of 1,500 feet.

Components 1C, 2A, and 5A - Widen the entrance channel, channel between buoys 13 and 15, and Fisherman's Channel;

Component 3B – Widen the Fisher Island Turning Basin;

Component 6 – Extend the Dodge Island Channel;

Component 6A – Construct the Dodge Island Turning Basin.

Incremental transit costs for the without project condition and each of the four proposed channel improvement component sets represent cost reduction benefits.

As discussed in previous sections, Maersk Sealand's SUSAN MAERSK was selected for the design vessel for the economic analysis. The SUSAN MAERSK has 1,138-feet length over all (LOA), a maximum beam of 140.8 feet, and a maximum design draft of 47.6 feet. It has a beam that is approximately 35 feet greater than the current Maersk Sealand container ships calling at Miami Harbor. The current widths of the entrance channel, channel between buoys 13 and 15, and the Fisherman's Channel are too narrow to allow the

SUSAN MAERSK to transit Miami Harbor safely and cost-effectively. The current channel configurations would necessitate an additional tug assistance and transit at a dead-slow speed.

The proposed improvement alternatives are necessary to accommodate the expected future fleet at Miami Harbor. Additionally, the proposed alternatives will alleviate delays resulting from turning basin use and one-way traffic restrictions and reduce transportation costs for nearly all users of Miami Harbor (note: cruise ships have priority berthing and pilotage because of tight schedules. As such, they do not experience delays). All commercial cargo vessels, regardless of size, however, experience vessel delays; and therefore, would benefit from widening of channels and turning basins, or similar improvements that result in improved maneuverability and reduced transit times.

The channel widening alternative is not intended to create two-way traffic for Post-Panamax or Panamax vessels. Rather widening creates an additional margin of safety that makes it possible for these vessels to traverse the project more expeditiously and fuel-efficiently and, in the case of Post-Panamax vessels, without extraordinary tug assistance. In addition, the widening helps reduce the surging effect on ships at dock along Fisherman's Channel. In the Biscayne Bay Pilots letter dated October 23, 1997, found in the Ship Simulation Modeling Report (Attachment B to Engineering Appendix B in Volume II of the Draft Miami Harbor Navigation Study General Reevaluation Report), the pilots state that the "...Lummus Island Cut just south of the gantry crane area should be widened. At the present time ships transiting this area pass extremely close to vessels docked at the gantry berths. This results in a "surging" effect on the ships at the dock. Also, all too frequently, we are encountering vessels docked at Lummus Island with their cranes swung outboard 90 degrees thereby blocking a portion of the channel."

According to one pilot's comments found at the end of the Ship Simulation Modeling Report after testing the proposed improvements (Attachment B to Engineering Appendix B in Volume II of the Draft Miami Harbor Navigation Study General Reevaluation Report). He states, "...Turning at Fisher Island is more expedient and potential surging of deep container vessels at the berths is minimized if not eliminated. For strong currents and depending on the location and number of deep draft vessels at the berths I would prefer the Lummus Island basin."

With Channel Improvements – The SUSAN MAERSK and other similarly sized Post-Panamax vessels traverse Miami Harbor at speeds of approximately 5-6 knots, with the assistance of 2 tugs. The transit to berth takes approximately 75 minutes. During this transit, the Post-Panamax vessels have exclusive use of the entrance channel and later Fisherman's Channel. Likewise, other large ships, e.g. Panamax, can traverse Miami Harbor at more optimal speeds (6-7 knots), resulting in reduced transit times.

Without project condition – The SUSAN MAERSK and other similarly sized Post-Panamax vessels traverse Miami Harbor as essentially "dead ships," pulled by 3 tugs at a speed of approximately 2-3 knots. The transit to berth takes nearly 2 hours. During this transit, the Post-Panamax vessels have exclusive use of the entrance channel and later

Fisherman's Channel. The narrow channel conditions also make it necessary for Panamax vessels to traverse the project at slower, less fuel-efficient speeds (4-5 knots versus 6-7 knots).

Three widening measures were combined into one alternative, because it is only with improvements to all three areas that the need for the third tug and less-than dead slow speed would be eliminated. With improvements, the container vessels would continue to light-load and require the assistance of two tugs, but could transit the channel at a more normal speed. The net impacts of the widening improvements are reductions in transit time and exclusive channel use of approximately 30 minutes per vessel, as well as elimination of the expense for the Post-Panamax vessels' third tug assistance.

A distinction needs to be made clear between delay benefits based on the reduction of "congestion" and the benefits claimed in the Miami Harbor economic analysis for channel widening improvements. The delays are caused by the interaction of vessels at the harbor. Delay type benefits can result from the reduction of inner harbor transit times and/or waiting times at the bar or at the berth due to conditions at a harbor. Improvements that result in benefits are the construction of a two-way transit channel and/or passing "lanes" and/or turning notches. At Miami Harbor, the outer and inner channels are restricted to one-way transits without or with the project improvements. Thus, the interaction of vessels is simplified, that is, an in-bound vessel(s) has to wait for the out-bound vessel to clear the bar. So, once the channel is clear, it's a straight "shot" to the berth. The proposed widening improvements are based on safety concerns raised by the Biscayne Bay Pilots Association with respect to groundings and passing container ships with their on-board cranes extended toward the channel as they load/unload at the berth using the landside gantry cranes. The widening alternatives address these concerns. However, the only benefits claimed are for efficiencies accruing to the Post-Panamax container ships. The widening of the channel at selected points results in removing safety restrictions for Post-Panamax container ships that will be implemented by the pilots in the without-project condition: reduced vessel speed (dead slow) and a third tug. The elimination of the one half hour of additional transit time and the third tug are not related to "congestion" at the Port. As stated, there is only one-way traffic. So, a vessel has to "clear" the bar before another can transit the channel. So, the one half hour of additional transit time for Post-Panamax container ships is strictly the time from the bar to the berth.

The primary source of data was derived from Miami Harbor's pilot logbooks. The data include detailed information on all aspects of vessel transits. For each vessel transiting Miami Harbor, a record is made in the pilot's log noting the vessel's characteristics, including transit date and time. Data records are made in the pilot's log upon entrance and exit of the harbor. An additional record is made if a pilot shift change occurs during the transit. The existing fleet characteristics are based on CY1999 pilot data.

Transit times for Miami Harbor navigation are largely a function of vessel speed. Variations in vessel speeds are due to vessel size and type and geographic limitations. The larger the vessel, the more difficult it is to maneuver, and therefore, the slower the transit speed. Restricted reaches along the channel also necessitate slower transit speeds. A survey of

Miami Harbor's pilots was conducted to elicit information on transit speeds by vessel class for each reach of the Miami Harbor navigation channel. Additionally, the pilots provided information on transit times based on experience by vessel type and destination berth.

Many berths share a common turning basin, which is generally located nearest the berths; therefore, a vessel in the turning basin obstructs channel entrance and egress for other users of the same turning basin. Nearly all vessels at Miami Harbor require the assistance of at least one tug; the additional width of the tug alongside the vessels increases the effective width of the vessel in the channel and constrains Miami Harbor to one-way traffic.

The berthing spaces previously enumerated in **Tables A-1** through **A-4** overstate the available capacity at Miami Harbor in that concurrent use of some adjacent berths is not possible and other adjacent berths must be combined to provide access for one large vessel. The width of the Fisherman's Channel constrains all commercial cargo traffic to one-way. The only passing that occurs involves small workboats and recreation craft. Vessels destined for berths on the Fisherman's Channel are delayed at the sea buoy, when another vessel is in the channel. Conversely, vessels departing Miami Harbor must wait at berth until the channel is cleared. According to Miami Harbor's pilots, channel delays exceeding one hour are not uncommon.

Vessels were divided into classes according to size and use. The vessel classifications describe the attributes of all vessel types that were analyzed. Vessel classifications were standardized for this effort and are summarized in **Table A-26**. The important characteristics of the existing vessel fleet are the dimensions and types of the vessels. Similarly, the commodities moving in and out of Miami Harbor were aggregated into commodity classes. For this effort, three commodity classes were identified: containers, Ro-Ro/general cargo, and passengers.

Table A-26. Vessel Class Definitions

Vessel Class Definitions		
Class	Type	Length
1	Container	LOA < 500
2	Container	LOA between 500 and 700
3	Container	LOA between 700 and 900
4	Container	Panamax
5	Container	Post-Panamax
6	Gen Cargo, Ro-Ro, Lo-Lo	LOA < 400
7	Gen Cargo, Ro-Ro, Lo-Lo	LOA between 400 and 600
8	Gen Cargo, Ro-Ro, Lo-Lo	LOA > 600
9	Passenger	LOA < 600
10	Passenger	LOA between 600 and 900
11	Passenger	Panamax
12	Passenger	Post-Panamax

Forecast commodity tonnage is displayed in **Table A-27**. As discussed in previous sections, the annual growth rates to be used for the 50-year study period for each of the general commodity groups (containers, 4.53 percent; Ro-Ro cargo, 4.53 percent; and passengers, 2.00 percent) are assumed to occur without or with any harbor improvements.

Table A-27. Forecast Commodity Tonnage

Forecast Commodity Tonnage Without Project/ With Project Conditions						
	2010	2020	2030	2040	2050	2060
Containers	9,058,295	16,827,157	30,565,148	42,247,460	58,394,870	80,713,985
Ro-Ro, Lo-Lo	5,095,291	9,465,276	17,192,896	23,764,196	32,847,114	45,401,616
Total	14,153,586	26,292,433	47,758,044	66,011,656	91,241,984	126,115,601
Cruise Passengers	4,183,511	5,099,676	6,216,477	7,577,851	9,237,357	11,260,287

Given forecast commodity traffic, future vessels calls were estimated. **Table A-28** displays forecast vessel calls at the port under the without project condition and the proposed channel improvement alternatives. As discussed in previous sections, the future fleet will include the addition of the SUSAN MAERSK and other post-Panamax containerships, as well as the continued arrivals of mega- cruise ships. Forecast commodity will be accommodated in the larger vessels in the future fleet, resulting in fewer vessels calls over the 50-year project life. This assumption was based on information obtained from Miami Harbor's shippers and was discussed in previous sections. It is important to note that the forecast future vessels calls are identical in the with and without project conditions (without deepening).

Table A- 28. Forecast Vessel Trips

Forecast Vessel Trips Without/ With Project Conditions						
Commodity	2010	2020	2030	2040	2050	2060
Containers	1,225	1,391	1,695	2,119	2,642	3,377
Ro-Ro, Lo-Lo	1,313	1,431	1,677	2,004	2,245	2,603
Cruise	1,177	1,224	1,278	1,366	1,525	1,690
Total	3,715	4,046	4,650	5,489	6,412	7,670

Methodology

Vessel operating costs by vessel class for FY2004 were obtained from the Institute for Water Resources (IWR). The costs represent daily operating costs for U.S. and foreign vessel classes engaged in trade at U.S. deep-draft ports and are specific for vessel flag, type, and size. The costs are published annually by IWR in an Economics Guidance Memorandum (EGM) and intended for use in Corps' planning studies. A representative vessel was selected for each vessel class and daily operating costs assigned accordingly, taking into consideration the distribution of domestic and foreign-flagged vessels within each class.

The delay reduction analyses for Miami Harbor were performed without the use of a congestion model. In the absence of a model, a reliable analysis was performed with the use of Excel spreadsheets, by employing similar logic. Each vessel call forecast for Miami Harbor was disaggregated into component movements, each with an associated estimated duration. A vessel call included the following components: 1) arriving at the sea buoy; 2) transiting to berth; 3) berthing; 4) departing the berth and Miami Harbor.

The project lent itself well to such analyses, given that the assumptions for the vessel fleet and traffic forecast were identical in the with- and without- project conditions. The vessel fleet composition is the same under the without- and with-project conditions for three reasons: (1) industry contact persons advised that when their steamship companies introduce Post-Panamax container ships into the European, Mediterranean, and Asian trades, they would continue to use "multi-porting" itineraries that would be similar to those currently in use; (2) if there were no physical constraints that prevent a Post-Panamax container ship from calling at a port, the Post-Panamax container ships would call even though a port's channel configuration may not provide the most efficient utilization of the larger vessels in the short-term, and (3) the Biscayne Bay Pilots Association advised that they would bring in the Post-Panamax container ships in the without-project condition using the current typical underkeel clearance of three feet, but at a significantly reduced speed (dead slow) and with an additional tug (three rather than two) assisting in the transit.

The Port of Miami did not have a turning basin of appropriate size to allow the Post-Panamax REGINA MAESK to call in 1999. With the construction of the Lummus Island Turning Basin in the without-project condition, there are no purely physical constraints preventing Post-Panamax container ships calling at Miami Harbor. Moreover, the pilots would take measures to reduce the risk of grounding the larger container ships: reduce the speed of the vessel and add a third tug.

Given economies in transportation, even a "light-loaded" Post-Panamax vessel results in a lower delivered cost per ton than that of a M-class vessel loaded to the same draft. So much so, that the costs of an additional tug assist and slower transit at Miami Harbor are preferred over the M-class vessel operating unencumbered at the project and on the same itinerary. Given that there are no physical constraints that exclude the S-class vessel from Miami Harbor and the additional transit costs are covered by its economic advantage, it is introduced in the without project condition. Therefore, inclusion of the S-class vessel represents optimization of the without project condition.

Given identical vessel calls in both scenarios, estimating the impacts of proposed improvements on the forecast vessel calls entailed focusing on / isolating only the areas where differences could occur ("areas," in this case, referring to vessel classes and/or components of the overall vessel transit times). In as much as the improvement alternatives removed constraints that contribute to vessel delays, benefits could be estimated for each future decade, with inner years interpolated.

Given the identical vessel fleet and future vessel calls at Miami Harbor in the with and without project conditions, detailed modeling of traffic was unnecessary with the following baseline assumptions:

1) Vessels would call at exactly the same berths with or without the project. The proposed improvements do not include additional berthing capacity.
2) Berthing time would be exactly the same with or without the project. The proposed improvements do not include enhancements to loading/unloading equipment that would not also be in place in a without project setting.
3) Vessels delayed at the sea buoy due to berthing capacity shortfalls (beyond the delays that are expected as the exiting vessels clear the project) are assumed to occur with or without the proposed improvements.
4) The precautions, in the form of slow transits for Panamax vessels, that the Biscayne Bay Pilots currently take, would continue and become more regulated as larger vessels are introduced with no corresponding channel improvements (without project condition).
5) Cruise ships have priority channel usage, and as such, do not experience delay.

The year 1999 was selected as a representative base year for analysis and forecasts. The future year (2010 through 2060) commodity tonnage volumes, vessel loadings, and distributions of vessel classes were extrapolated from pilot data and commodity traffic forecasts discussed in previous sections.

In the absence of modeling, it was still necessary to develop shipment lists for Miami Harbor. A critical input for any congestion model is the expected stream of vessel movements, or shipment list. The shipment list is an annual account of vessel movements specific to the arrival date and time, vessel type and size, commodity type and volume, and destination berth. Shipment lists are developed from an analysis of actual traffic patterns. Future year shipment lists are randomly generated from vessel traffic distribution patterns developed from historic data and increased at a rate commensurate with forecast growth in commodities. The important considerations are the number, types, and sizes of vessel expected to call at Miami Harbor over the life of the project. While the "no-model" method inevitably results in understated estimates of delay at Miami Harbor, it was nevertheless a reliable means of estimating the most-easily quantifiable sources of delay costs.

According to the Biscayne Bay Pilots' Association (BBPA), the transit method and resultant time for a Post-Panamax container vessel would differ greatly between the unimproved without project condition and the improved condition. The BBPA are an invaluable source of information on regarding vessel maneuvers in Miami Harbor. While acknowledging that there would be no physical constraints, the S-class vessel transit would be "tight," necessitating a reduced speed and additional tug assist. Thus given estimates of future vessel calls, which were identical with or without the project, expected delays and delay costs were calculated. Additionally, the estimates of future vessel calls determined the foregone need for a third tug assist. Beyond these estimates, additional delay would be expected to occur as vessels randomly interact with one another –delay that would be mitigated by a more efficient channel configuration. The 30-minute reduction per vessel in transit time translated into 30 additional minutes in the with project condition that the channel was available for use by other vessels, rather than obstructed by the S-class vessel's transit.

For each alternative and decade, transit times including assumed transit delays, were estimated by individual vessel movement. Excel spreadsheets were used to calculate transit time costs by vessel class for each forecast vessel trip, given hourly operating costs by vessel class. For example, to calculate the total transit time for the without project condition in 2010, an annual list of movements was constructed in an Excel spreadsheet. Each movement, given its unique vessel class, commodity type, and origin/destination berth, was assigned an estimated transit time. The transit time included the following components: arrival, berthing, departure, and delay. The Miami Harbors' pilot data, as well as interviews with pilots, provided valuable insights into these component times. **Table A-29** provides an example calculation of per trip incremental cost savings for the SUSAN MAERSK in 2010.

Table A-29. Miami Harbor Cost Reduction Analysis Example

Miami Harbor Cost Reduction Analysis Example Class 5 Containership, 2010		
	Without Project	With Improvements
Transit Time Inbound	1 Hr 48 Min	1 Hr 18 Min
Berth Time	18Hr	18Hr
Transit Time Outbound	71 Min	41 Min
Hourly Operating Cost - at Sea	$2,310	$2,310
Hourly Operating Cost - at Port	$1,259	$1,259
Subtotal Port Cost	$29,939	$27,629
Total Vessel Calls	3,715	3,715
Hourly Arrival Rate*	0.85	0.85
Probability of Encounter	0.72	0.72
Expected Delay Time**	51 Min	30 Min
Expected Delay Cost	$1,964	$1,155
No. of Tugs	3	2
Tug Cost (@ $1,400/hour)	$4,200	$2,800
Total Port Cost	$36,102	$31,584
Incremental Savings Per Call		$4,519

* Annual vessel calls per hour, assuming that with each vessel call there are two legs, or trips (inbound and outbound).

** Expected delay is a function of forecast annual vessel trips. The square of the expected hourly arrival rate represents the probability of a vessel encounter in the channel. Given the one-way traffic constraint, one vessel must yield, and is, therefore, delayed. The delay is set equal to the vessel outbound transit time, and the expected delay time is the product of the outbound transit time and the probability of vessel encounter.

Similar estimates for 2010 were developed for each of the vessel classes and all of the improvement alternatives. The total transit times for the improvement alternatives were compared to the without project condition estimate for each decade. Excel spreadsheets were used to estimate average annual transit costs for each alternative (transit costs between decadal points were interpolated). Incremental transit costs for the without project condition and the improvement alternatives represent cost reduction benefits.

The following summarizes the assumptions for three of the cost reduction benefit alternatives (the fourth, or the Dodge Island Channel Extension, is discussed in the section entitled "Cruise Ship Benefits"):

1). Widening entrance channel, buoys 13-15 and Fisherman's channel - In the absence of improvements in Miami Harbor, the SUSAN MAERSK and similarly-sized vessels, would need to light-load and transit the channel with the assistance of three tugs at a less than dead-slow speed. Consequently, the transit would be 30 minutes slower than normal. Three tug assists represent one additional tug assist over normal operating conditions. The third tug assist would be necessary through each of the three widening components. For example, in the absence of the outer entrance channel flare, a third tug assist would be necessary to allow safe transit of the SUSAN MAERSK or similarly sized vessel. The three widening alternatives were combined into one system, because it is only with improvements to all three areas that the need for the third tug and less-than dead slow speed would be eliminated. The container fleet distribution would change over time, eventually composed mainly of S-class (Post-Panamax) vessels in the Far East and European trades. With improvements, the container vessels would continue to light-load and require the assistance of two tugs, but could transit the channel at a more normal speed. The incremental savings are the foregone costs of the third tug assist and reduced transit time. (input from Biscayne Bay pilots and Coastal Tug and Barge).

2). Widening Fisher Island Turning Basin - In the absence of improvements, Post-Panamax vessels calling at Miami are constrained to use of the Lummus Island turning basin only, resulting in additional transit time and delays for vessels berthing closest to the Fisherman's Channel entrance. With improvements, vessels have the option of turning before or after berthing. Pilots will have more flexibility to manage traffic and minimize delays within Miami Harbor. The incremental savings are the reduced transit times and delays for vessels transiting and berthing on Fisherman's channel.

3). Constructing Dodge Island Turning Basin - In the absence of improvements, cruise ships on the south pier would use the Lummus Island turning basin for maneuvering. Given the priority of cruise ships in Miami Harbor, such use would interfere with commercial cargo operations and result in delays for cargo vessels. With improvements, the cruise ships would have an exclusive turning basin. The incremental savings are the foregone interference and delay costs for cargo vessels transiting Fisherman's channel. The interference costs take into account the cruise ships schedule and probability of being delayed.

Cruise Ship Benefits

In analyzing the benefits of the Dodge Island Channel extension, a different technique was used. According to guidance developed by IWR, benefits associated with cruise ships from harbor improvements could accrue from three sources: 1) existing vessels using a harbor under without-project conditions operate more efficiently in that same harbor under with-project conditions; 2) vessels using one harbor under without-project conditions transfer to the improved harbor under with-project conditions; and 3) new vessels (larger, with more amenities) begin using a harbor under with-project conditions that they did not use under without-project conditions. Benefits could accrue to both vessel operators and passengers under each of the three scenarios.

The difficulty in estimating cruise ship benefits lies in the fact that cruise ships are unique -- ships of the same class cannot be compared to one another when they operate on differing itineraries; likewise differing ships operating on the same, or nearly the same itineraries are not comparable. The comparisons are made more difficult given that the cruise ship companies are not forthcoming with financial information that could be used to estimate daily operating costs or indicate individual vessel performance

Cruise companies measure their vessels' performance in terms of "yield," that is net income per passenger cruise day. A passenger cruise day is one passenger sailing for a period of one day. For example, one passenger sailing on a one-week cruise is seven passenger cruise days. Each vessel within a company's fleet for a given itinerary and season has a unique yield, or profitability. Newer, larger ships tend toward greater levels of profitability, due to economies of scale in provisioning and staffing, as well as increased revenue-generating opportunities from the larger passenger population. Given that the newest mega-ships are destinations in themselves, the income generated per passenger day tends to exceed that of other ships in the fleet. Certain itineraries are more popular, and consequently, more profitable.

A survey of cruise companies' financials provided an estimate of their respective yield or net income per passenger day. The limitation is that the yield is a gross figure for the company. Certainly yields vary quite a bit by vessel and itinerary. Cruise companies are not forthcoming with any specific information on the performance of individual vessels, or even classes of vessels. For this analysis, the financials of three companies were analyzed to develop an estimate of net income per passenger day -- Royal Caribbean Cruise Lines, P&O Princess Cruises, and Carnival Corporation.

These companies were selected because of their market dominance and current operations in Miami Harbor. An estimated net income per passenger day served as a proxy for estimating benefits for improvements at Miami Harbor. In the absence of improvements at Dodge Island, the cruise ship HORIZON would represent the maximum-sized/capacity vessel that could operate on the south pier. The vessel LOA is 727 feet and it passenger capacity is 1,798. With improvements, a larger vessel could operate in place of the HORIZON. The design vessel is the CARNIVAL DESTINY, which has an LOA of 893 feet and a passenger capacity of 2,642. **Table A-30** provides a comparison of the two cruise vessels. Given an identical itinerary, the CARNIVAL DESTINY could accommodate 150 percent of the number of passengers per trip. While additional passengers and a larger vessel result in higher costs per voyage, the opportunity to use the larger vessel on the same itinerary will result in increased income. The incremental benefits are the net incomes that accrue from the additional passengers. The annual reports of the major cruise lines were referenced to calculate a representative net income per passenger estimate. Over time, as the demand for cruises increase, additional vessels would be expected to berth on the south pier.

Table A-30. Miami Harbor Cruise Ship Comparison

Miami Harbor Cruise Ship Comparison Vessel Characteristics		
Item	*Horizon*	*Carnival Destiny*
Gross Registered Tons(GRT)	46,811	101,353
Net Registered Tons (NRT)	24,471	73,081
Deadweight Tonnage (DWT)	5,550	11,142
Length Overall (LOA)	683.8	895.1
Molded Breadth	96.3	116.7
Maximum Draft	24.4	27.3
Year Delivered	1990	1996
Passenger Capacity	1,798	2,642
Crew Capacity	641	1,040
Passenger/Crew Ratio	2.8	2.5
Service Speed	19.5	22.5

Assuming operation of a 7-day itinerary out of Miami Harbor, twenty-six weeks per year initially, increasing to 52-weeks annually, an estimated 41,000 passenger cruise days are lost when the HORIZON is employed in place of the CARNIVAL DESTINY. This loss translates into reductions in net income of more than $0.5 million per year.

Analysis Results

Incremental savings, by decade, for each of the channel improvement components sets are presented in **Table A-31**. Each of the components sets result in significant transportation cost reductions over the without project condition. The Channel Widening results in average annual savings ranging from $ 0.6 million in 2010 to $ 15.1 million in 2060. While the entrance channel widening provides safe navigation for the SUSAN MAERSK and other post-Panamax vessels, another advantage of the widened channel is that it allows smaller vessels (maximum 80' beam) to pass in the channel. These vessels make up a significant proportion of traffic at Miami Harbor. Given that cruise ships do not experience delays because of priority berthing and pilotage, no delay reduction savings were claimed for any of their vessel classes.

Table A-31. Annual Transportation Costs

Annual Transportation Cost Savings (Thousands of FY04 dollars)						
Alternatives	2010	2020	2030	2040	2050	2060
Without Project Condition	--	--	--	--	--	--
Widening (EC, Buoys 13-15, FC)	$431	$1,455	$3,585	$5,466	$9,663	$15,565
Fisher Island Turning Basin Widening	$250	$639	$1,515	$2,570	$4,416	$7,239
Dodge Island Channel Extension	$529	$1,058	$2,115	$2,115	$2,115	$2,115
Dodge Island Turning Basin Construction	$519	$650	$773	$943	$1,123	$1,339

Cost reduction benefits for the proposed channel improvement alternatives for Miami Harbor are summarized in **Table A-32**. The benefits reflect an interest rate of 5 5/8 percent and October 2003 price levels.

Table A-32. Miami Harbor Cost Reduction Benefits Summary

Miami Harbor Improvement Component Sets Benefit Summary (Thousands of FY04 dollars)		
Alternatives	Total Present Worth	Average Annual Benefits
Without Project Condition	--	--
Widening (Ent. Chan., Buoys 13-15, Fishmn's Chan.)	$47,343	$2,848
Fisher Island Turning Basin Widening	$21,483	$1,292
Dodge Island Channel Extension	$23,014	$1,384
Dodge Island Turning Basin Construction	$12,158	$731

Vessel Utilization Savings (Deepening Benefits)

Transportation costs for the without- and with-project conditions were estimated in one-foot increments to compute the National Economic Development (NED) benefits associated with the project deepening. The difference between the without- and with-project costs represents the benefits of the deepened channel. Cost efficiencies accrue as vessels are able to increase loading and reduce transits. It should be noted that delay reduction benefits that are discussed and calculated in Cost Reduction Benefits are not part of the costs used to estimate channel deepening benefits.

Total transportation costs are estimated using the specifications of each vessel (average deadweight, length overall, beam, design draft, speed, and so forth) along with estimated vessel transit characteristics, transit mileage, and vessel hourly operating cost data developed by the Corps' Institute for Water Resources (IWR).

Vessels Potentially Benefiting from Channel Deepening
The Miami Harbor Port Authority provided vessel call data for fiscal year 1999. These data were used to determine which vessels would benefit from deepening the Federal channel. Vessels currently calling that could benefit from a deeper channel at Miami Harbor are the Panamax Class vessels represented by the Maersk Sealand M-class container ships; vessels expected to call in the future that could benefit are Post Panamax container ships, like the design container ship, Susan Maersk, a Maersk Sealand S-class vessel. The analysis assumes that as the Post Panamax vessels begin to call at Miami Harbor, they will gradually replace smaller Sub Panamax vessels; in later years of the project, they will gradually replace some of the Panamax vessels. The analysis focused on these vessel classes and their proportion of the total cargo handled by the Port.

Vessel Specifications and Applied Lading Capacities
The vessel characteristics of all vessels calling during FY 1999 were obtained from Lloyd's Register of Ships, April 2001 CD-ROM.

The lading capacity by volume of the container vessel refers to the number of short tons of cargo and container boxes the vessel will carry when its TEU slots are full, given the weight of a typical container. The weight of a typical container incorporates the weight of the container, the percentage of empty containers, and the average weight of the cargo carried in a filled container.

Independent of its lading capacity by volume, the vessel's lading capacity by weight refers to the maximum number of tons of cargo it can hold regardless of whether its cargo area is volumetrically filled; it equals the deadweight of the vessel less the weight of its non-cargo components.

For a container vessel carrying many empty or light-weighted containers, the lading capacity by weight may exceed the actual capacity of the vessel. For a vessel carrying many full and heavy-weighted containers, the lading capacity by volume may exceed the actual capacity of the vessel. The applied lading capacity of the container vessel refers to its actual capacity given the percentage of empty containers it is carrying and the average weight of its filled containers; it equals the lesser of the lading capacity by weight and the lading capacity by volume.

Table A-33 shows the vessel specifications and applied lading capacities of the container vessels expected to benefit from channel deepening. For the Susan Maersk and the Madison Maersk, lading capacity by weight exceeds lading capacity by volume. This implies that the number of TEU containers these vessels are designed to carry, given the expected weight of the average container, is the factor that limits their capacities. The vessels could carry more cargo, but only by increasing the average loaded weight of the containers they carry.

For the other vessel classes shown, lading capacity by volume exceeds lading capacity by weight. The capacity of each vessel is reached with fewer containers than it is designed to carry, given the expected weight of the average container. This implies that the applied lading capacities shown for these vessels closely represent the true maximum cargo weight they are designed to carry. Increasing the average container weight would require reducing the number of containers carried to compensate.

Fully-Loaded Transit Weight and Applied Maximum Transit Draft

The stated design draft of a vessel is related both to its rated deadweight and to the densest cargo the vessel is designed to carry. The vessel's deadweight assumes both a cargo tonnage level based on the vessel's lading capacity by weight and that the vessel contains 100 percent of its fuel, stores, water, and crew capacity, plus any ballast the vessel is expected to carry. Accordingly, the design draft refers to the maximum possible draft of the vessel.

In contrast, a vessel's applied maximum transit draft is a more accurate prediction of the vessel's deepest draft when traversing a harbor because it is based on a lesser, more likely non-cargo deadweight and a cargo weight equal to the vessel's applied lading capacity. Fuel (bunkerage) represents about 80 percent of non-cargo deadweight; stores, water, and crew requirements together represent about 20 percent. The portion of the vessel's fuel, stores, water, and crew weight remaining upon the vessel's arrival at Miami Harbor is estimated to be two thirds of the full amount. A certain amount of ballast water will also be carried, based on design specifications provided by vessel owners. Adding the adjusted non-cargo weight to the adjusted cargo weight gives the total transit weight of the fully loaded vessel.

Specifically, the amount of weight a vessel carries drives its transit draft. Guidelines from IWR provide the gross cargo capacity of a vessel as a percentage of its deadweight. For example, (see Table A-33), the gross cargo capacity for the Regina Maersk is 94.2%, so the most cargo weight the vessel is able to carry is 79,999 short tons. IWR also supplies expected ballast as a percentage of deadweight, based on vessel type. For container vessels, the ballast assumption is 7.88%, so for the Regina Maersk, ballast is expected to weigh 6,690 short tons. A vessel carrying 94.2% of its deadweight in cargo and 7.88% of its deadweight in ballast would be expected to sail at its maximum, or design draft, because its transit weight is expected to at least match, if not exceed, its deadweight.

However, container vessels often sail at less than their design drafts because the average cargo weight carried per TEU slot is low enough that the TEU slots are accounted for—either by cargo-filled containers, empty containers, or no container—before maximum cargo by weight has been achieved. In this case, the vessel has "cubed out" because its lading capacity by volume is less than its lading capacity by weight.

Whether a vessel first cubes out or reaches its cargo capacity by weight depends on both the design of the vessel and conclusions concerning expected percentage of empty slots, percentage of empty containers carried, and short tons per filled container, which drive the calculation of average weight carried per TEU slot. For Miami Harbor, an analysis was conducted to determine the appropriate parameters to use in the determination of average weight carried per TEU slot. This analysis included (1) as mentioned, IWR data (Table IV-5, Adjustments For Estimating Actual Vessel Capacity, National Economic Development Procedures Manual Deep Draft Navigation, IWR Report 91-R-13, November 1991), (2) vessel capacity data from steamship companies, and (3) actual vessel call data from the Port's database.

The IWR factors (assumptions) for converting design capacity to maximum transit capacity were used as a starting point for the fleet calling at Miami Harbor, as they are based on a broad range of container vessels, under various conditions, which would be generally applicable over time. As a refinement, Maersk graciously provided a detailed breakdown of the deadweight for the design vessel, the SUSAN MAERSK: cargo deadweight, ballast, bunkers and miscellaneous stores tonnage. Maersk also provided the immersion factor as well as the average container weight (cargo and tare weight). The container weight represents an average weight for most of Maersk's services. This information was critical to the analysis as the design vessel class accrues the most benefits from the channel improvements over the 50-year study period.

The third set of data that was factored into the analysis to establish a maximum applied transit capacity and draft was the actual "static" drafts recorded at the Port of Miami by the Biscayne Bay Pilots Association in 1999. This information, which is displayed in Table A-22, reflects current vessel itineraries. As can be observed when comparing the static drafts in this table to the design and maximum applied transit drafts in Table A-33, the largest Panamax container ships (LOA > 950 feet) do not typically fully utilize their design drafts of 44 feet after taking into account underkeel clearance and tide use.

As shown in Table A-33, the maximum applied transit drafts of the ships representing each vessel class are set below their design drafts except for three exceptions (two Post-Panamax classes and the Sub-Panamax class) for reasons described above. It should be noted that the maximum applied transit draft of the design vessel class (SUSAN MAERSK), which will benefit most from the channel improvements, is set at 1.5 feet below its design draft. Thus, even though containerized cargo is forecasted to grow over time, this class of vessels is expected to typically draft less than its design draft.

The immersion rate is the number of tons stowed per inch of draft. Immersion rates are developed for each vessel using an equation provided for different vessel types by the Maritime Administration (MARAD) of the U.S. Department of Transportation. The key vessel characteristics are design draft, length between perpendiculars, maximum breadth, and service speed.

The difference between the total transit weight and the deadweight divided by the immersion rate produces the expected deviation from the design draft in inches. Applying this deviation to the design draft yields the applied maximum transit draft of the vessel, which corresponds to the expected draft of the fully loaded vessel on a typical arrival to or departure from Miami Harbor. In cases in which the total transit weight exceeds the deadweight, zero deviation from deadweight is used, so the calculated applied maximum transit draft equals the design draft.

Table A-33 shows the fully loaded transit weight and applied maximum transit drafts of the container vessels expected to benefit from channel deepening.

Table A-33: Vessel Specifications and Applied Lading Capacities of Benefiting Container Vessel Fleet at Miami Harbor

	Susan Maersk (Post-Panamax)	Regina Maersk (Post-Panamax)	Composite Other Post-Panamax	Madison Maersk (Panamax)	Zim Asia (Sub-Panamax)
Deadweight (Short Tons)	104,696	84,900	67,417	66,524	50,540
Length Between Perpendiculars	1,088	992	863	933	792
Extreme Breadth	140	141	132	106	106
Design Draft (Feet)	47.6	45.9	46.0	44.4	38.6
Speed (Knots per Hours)	24.6	25.0	25.5	24.0	21.7
Gross Cargo Capacity	95.5%	94.2%	93.3%	93.3%	92.3%
Lading Capacity by Weight (Short Tons)	100,011	79,999	62,869	62,036	46,639
TEU Capacity	6,418	6,418	5,340	3,922	3,429
Lading Capacity by Volume	88,008	88,008	73,222	53,781	47,021
Applied Lading Capacity (Short Tons)	88,008	79,999	62,869	53,781	46,639
Bunkerage, Stores, Water, Crew (Short Tons)	3,123	3,267	3,032	2,992	2,601
Ballast (Short Tons)	8,250	6,690	5,312	5,242	3,983
Fully Loaded Transit Weight	99,381	89,956	71,213	62,015	53,222
Block Plane Coefficient	0.66	0.62	0.59	0.67	0.65
Water Plane Coefficient	0.79	0.76	0.74	0.80	0.78
Immersion Rate (Short Tons per Inch)	320.22	257.20	203.68	190.78	159.11
Deviation from Design Draft (feet)	1.38	0.00	0.00	1.97	0.00
Applied Maximum Transit Draft	46.2	45.9	46.0	42.4	38.6
Fully Loaded Transit Depth Requirement	49.2	48.9	49.0	45.4	41.6

Underkeel Clearance

A sample of historical transit drafts of vessels calling at Miami Harbor were matched with actual tide elevations occurring at the times of transit. These data were assembled in spreadsheets and analyzed to identify the minimum underkeel clearance used by each vessel as it transited the channel. The analysis showed that the historical minimum underkeel clearance is at least three feet for Panamax container ships.

Maersk Sealand has a standard of 1.1 meters (3.6 feet) for underkeel clearance for its containerships when they are underway. A review of current practice for the Maersk Sealand Panamax Class (M-class) shows that they use at least three feet of underkeel clearance at the dock. Taking into consideration the Corps of Engineers channel design standard of three feet of underkeel clearance for hard bottom channels, the current actual practice of using at least three feet of underkeel clearance at the dock, and the Maersk Sealand standard of 3.6 feet of underkeel clearance while underway, three feet of underkeel clearance was used for the economic analysis for the large container ships. It should be noted that through a partnering agreement other shipping companies ship their containers on the Maersk Sealand vessels. So, with respect to Maersk Sealand vessels, the Maersk Sealand M-class and S-class container ships are considered generic; that is, they represent similar size container ships owned by other shipping companies.

Fully Loaded Transit Depth Requirement
The applied maximum transit draft of the vessel plus the appropriate underkeel allowance equals the fully loaded transit depth requirement of the vessel, which is shown for each container vessel class in **Table A-33**.

Vessel Itineraries
Trade routes for the benefiting vessels are discussed in a previous section entitled "Current Trade Routes and Vessel Itineraries." For benefit estimation, these trade routes were standardized into the following three trade routes: Far East, Mediterranean, and European.

Applicable Channel Constraint, Applied Maximum Transit Depth, Actual Transit Draft, Lading in Short Tons, and Total Transit Weight of Vessel
A critical factor in the analysis is whether the drafts of the container ships calling at Miami Harbor are constrained by the channel depths at the previous and subsequent ports of call or by depths in canals such as the Suez Canal or the Panama Canal. The channel depths of ports within trade route itineraries are presented in **Table A-25**. The constraining channel depths of concern to each itinerary and vessel class are displayed in **Table A-34** through **Table A-43.**

The applied maximum transit depth, which is a function of the vessel and its trade route, is the greatest depth a vessel transiting Miami Harbor could utilize given its maximum transit draft and the constraints it faces at its port of origin or destination or required canal transit. Light loading by the vessel could be eliminated by additional increments of deepening at Miami Harbor as long as the applied maximum transit depth is greater than the without-project depth. The point at which the channel depth equals the applied maximum transit depth is the point at which the channel depth fully accommodates the vessel's needs; no additional depth is beneficial for that vessel.

The actual transit draft of the vessel is the lesser of the channel depth and the maximum transit depth, less the underkeel allowance. The deviation of the actual transit draft from the maximum transit draft applied to the immersion factor gives the amount of light loading necessary to accommodate the actual transit depth. Subtracting the light-loaded tonnage from the applied lading capacity results in the actual short tons carried by the arriving or departing vessel. This actual lading increases as the channel is deepened until light loading has been eliminated.

Adding the actual lading at each channel depth to the estimated short tons of crew, stores, water, bunkerage, and ballast carried by the transiting vessel (see **Table A-33**) produces the expected total transit weight of the vessel at each channel depth.

Tables A-34 to **A-43** show the channel or canal constraint, the applied maximum transit depth, the actual transit draft by project depth, lading in short tons by project depth, and the total transit weight of the vessel by project depth of each vessel class for each trade route for the inbound and outbound transits at Miami Harbor.

Table A-34: Channel or Canal Restraint, Applied Maximum Transit Depth, Actual Transit Draft, Lading in Short Tons, and Total Transit Weight in Short Tons for Inbound Susan Maersk at Miami Harbor

	Susan Maersk (Post-Panamax) - Far East Trade Region	**Susan Maersk (Post-Panamax) - Europe Trade Region**	**Susan Maersk (Post-Panamax) - Mediterranean Trade Region**
Channel or Canal Restraint	Hong Kong, China	U.S. East Coast Port	U.S. East Coast Port
Channel Constraint at Port of Origin or Canal Restraint (Feet)	49.2	49.0	49.0
Applied Maximum Transit Depth	49.2	49.0	49.0
Actual Transit Draft at 42 Feet	39.0	39.0	39.0
Actual Transit Draft at 43 Feet	40.0	40.0	40.0
Actual Transit Draft at 44 Feet	41.0	41.0	41.0
Actual Transit Draft at 45 Feet	42.0	42.0	42.0
Actual Transit Draft at 46 Feet	43.0	43.0	43.0
Actual Transit Draft at 47 Feet	44.0	44.0	44.0
Actual Transit Draft at 48 Feet	45.0	45.0	45.0
Actual Transit Draft at 49 Feet	46.0	46.0	46.0
Actual Transit Draft at 50 Feet	46.2	46.0	46.0
Lading at 42 Feet	60,391	60,391	60,391
Lading at 43 Feet	64,234	64,234	64,234
Lading at 44 Feet	68,076	68,076	68,076
Lading at 45 Feet	71,919	71,919	71,919
Lading at 46 Feet	75,762	75,762	75,762
Lading at 47 Feet	79,604	79,604	79,604
Lading at 48 Feet	83,447	83,447	83,447
Lading at 49 Feet	87,290	87,290	87,290
Lading at 50 Feet	88,008	87,290	87,290
Total Transit Weight - 42 Feet	71,764	71,764	71,764
Total Transit Weight - 43 Feet	75,607	75,607	75,607
Total Transit Weight - 44 Feet	79,450	79,450	79,450
Total Transit Weight - 45 Feet	83,292	83,292	83,292
Total Transit Weight - 46 Feet	87,135	87,135	87,135
Total Transit Weight - 47 Feet	90,978	90,978	90,978
Total Transit Weight - 48 Feet	94,820	94,820	94,820
Total Transit Weight - 49 Feet	98,663	98,663	98,663
Total Transit Weight - 50 Feet	99,381	98,663	98,663

Table A-35: Channel or Canal Restraint, Applied Maximum Transit Depth, Actual Transit Draft, Lading in Short Tons, and Total Transit Weight in Short Tons for Outbound Susan Maersk at Miami Harbor

	Susan Maersk (Post-Panamax) - Far East Trade Region	**Susan Maersk (Post-Panamax) - Europe Trade Region**	**Susan Maersk (Post-Panamax) - Mediterranean Trade Region**
Channel or Canal Restraint	U.S. East Coast Port	Southampton, England	Valletta, Malta
Channel Constraint at Port of Origin or Canal Restraint (Feet)	49.0	49.2	50.6
Actual Transit Draft at 42 Feet	39.0	39.0	39.0
Actual Transit Draft at 43 Feet	40.0	40.0	40.0
Actual Transit Draft at 44 Feet	41.0	41.0	41.0
Actual Transit Draft at 45 Feet	42.0	42.0	42.0
Actual Transit Draft at 46 Feet	43.0	43.0	43.0
Actual Transit Draft at 47 Feet	44.0	44.0	44.0
Actual Transit Draft at 48 Feet	45.0	45.0	45.0
Actual Transit Draft at 49 Feet	46.0	46.0	46.0
Actual Transit Draft at 50 Feet	46.0	46.2	46.2
Lading at 42 Feet	60,391	60,391	60,391
Lading at 43 Feet	64,234	64,234	64,234
Lading at 44 Feet	68,076	68,076	68,076
Lading at 45 Feet	71,919	71,919	71,919
Lading at 46 Feet	75,762	75,762	75,762
Lading at 47 Feet	79,604	79,604	79,604
Lading at 48 Feet	83,447	83,447	83,447
Lading at 49 Feet	87,290	87,290	87,290
Lading at 50 Feet	87,290	88,008	88,008
Total Transit Weight - 42 Feet	71,764	71,764	71,764
Total Transit Weight - 43 Feet	75,607	75,607	75,607
Total Transit Weight - 44 Feet	79,450	79,450	79,450
Total Transit Weight - 45 Feet	83,292	83,292	83,292
Total Transit Weight - 46 Feet	87,135	87,135	87,135
Total Transit Weight - 47 Feet	90,978	90,978	90,978
Total Transit Weight - 48 Feet	94,820	94,820	94,820
Total Transit Weight - 49 Feet	98,663	98,663	98,663
Total Transit Weight - 50 Feet	98,663	99,381	99,381

Table A-36: Channel or Canal Restraint, Applied Maximum Transit Depth, Actual Transit Draft, Lading in Short Tons, and Total Transit Weight in Short Tons for Inbound Regina Maersk at Miami Harbor

	Regina Maersk (Post-Panamax) - Far East Trade Region	**Regina Maersk (Post-Panamax) - Europe Trade Region**	**Regina Maersk (Post-Panamax) - Mediterranean Trade Region**
Channel or Canal Restraint	Hong Kong, China	U.S. East Coast Port	U.S. East Coast Port
Channel Constraint at Port of Origin or Canal Restraint (Feet)	49.2	49.0	49.0
Applied Maximum Transit Depth	48.9	48.9	48.9
Actual Transit Draft at 42 Feet	39.0	39.0	39.0
Actual Transit Draft at 43 Feet	40.0	40.0	40.0
Actual Transit Draft at 44 Feet	41.0	41.0	41.0
Actual Transit Draft at 45 Feet	42.0	42.0	42.0
Actual Transit Draft at 46 Feet	43.0	43.0	43.0
Actual Transit Draft at 47 Feet	44.0	44.0	44.0
Actual Transit Draft at 48 Feet	45.0	45.0	45.0
Actual Transit Draft at 49 Feet	45.9	45.9	45.9
Actual Transit Draft at 50 Feet	45.9	45.9	45.9
Lading at 42 Feet	58,703	58,703	58,703
Lading at 43 Feet	61,789	61,789	61,789
Lading at 44 Feet	64,876	64,876	64,876
Lading at 45 Feet	67,962	67,962	67,962
Lading at 46 Feet	71,048	71,048	71,048
Lading at 47 Feet	74,135	74,135	74,135
Lading at 48 Feet	77,221	77,221	77,221
Lading at 49 Feet	79,999	79,999	79,999
Lading at 50 Feet	79,999	79,999	79,999
Total Transit Weight - 42 Feet	68,660	68,660	68,660
Total Transit Weight - 43 Feet	71,747	71,747	71,747
Total Transit Weight - 44 Feet	74,833	74,833	74,833
Total Transit Weight - 45 Feet	77,919	77,919	77,919
Total Transit Weight - 46 Feet	81,006	81,006	81,006
Total Transit Weight - 47 Feet	84,092	84,092	84,092
Total Transit Weight - 48 Feet	87,179	87,179	87,179
Total Transit Weight - 49 Feet	89,956	89,956	89,956
Total Transit Weight - 50 Feet	89,956	89,956	89,956

Table A-37: Channel or Canal Restraint, Applied Maximum Transit Depth, Actual Transit Draft, Lading in Short Tons, and Total Transit Weight in Short Tons for Outbound Regina Maersk at Miami Harbor

	Regina Maersk (Post-Panamax) - Far East Trade Region	**Regina Maersk (Post-Panamax) - Europe Trade Region**	**Regina Maersk (Post-Panamax) - Mediterranean Trade Region**
Channel or Canal Restraint	U.S. East Coast Port	Southampton, England	Valletta, Malta
Channel Constraint at Port of Origin or Canal Restraint (Feet)	49.0	49.2	50.6
Actual Transit Draft at 42 Feet	39.0	39.0	39.0
Actual Transit Draft at 43 Feet	40.0	40.0	40.0
Actual Transit Draft at 44 Feet	41.0	41.0	41.0
Actual Transit Draft at 45 Feet	42.0	42.0	42.0
Actual Transit Draft at 46 Feet	43.0	43.0	43.0
Actual Transit Draft at 47 Feet	44.0	44.0	44.0
Actual Transit Draft at 48 Feet	45.0	45.0	45.0
Actual Transit Draft at 49 Feet	45.9	45.9	45.9
Actual Transit Draft at 50 Feet	45.9	45.9	45.9
Lading at 42 Feet	58,703	58,703	58,703
Lading at 43 Feet	61,789	61,789	61,789
Lading at 44 Feet	64,876	64,876	64,876
Lading at 45 Feet	67,962	67,962	67,962
Lading at 46 Feet	71,048	71,048	71,048
Lading at 47 Feet	74,135	74,135	74,135
Lading at 48 Feet	77,221	77,221	77,221
Lading at 49 Feet	79,999	79,999	79,999
Lading at 50 Feet	79,999	79,999	79,999
Total Transit Weight - 42 Feet	68,660	68,660	68,660
Total Transit Weight - 43 Feet	71,747	71,747	71,747
Total Transit Weight - 44 Feet	74,833	74,833	74,833
Total Transit Weight - 45 Feet	77,919	77,919	77,919
Total Transit Weight - 46 Feet	81,006	81,006	81,006
Total Transit Weight - 47 Feet	84,092	84,092	84,092
Total Transit Weight - 48 Feet	87,179	87,179	87,179
Total Transit Weight - 49 Feet	89,956	89,956	89,956
Total Transit Weight - 50 Feet	89,956	89,956	89,956

Table A-38: Channel or Canal Restraint, Applied Maximum Transit Depth, Actual Transit Draft, Lading in Short Tons, and Total Transit Weight in Short Tons for Inbound Composite Other Post-Panamax Container Vessels at Miami Harbor

	Composite Other Post-Panamax - Far East Trade Region	**Composite Other Post-Panamax - Europe Trade Region**	**Composite Other Post-Panamax - Mediterranean Trade Region**
Channel or Canal Restraint	Hong Kong, China	U.S. East Coast Port	U.S. East Coast Port
Channel Constraint at Port of Origin or Canal Restraint (Feet)	49.2	49.0	49.0
Applied Maximum Transit Depth	49.0	49.0	49.0
Actual Transit Draft at 42 Feet	39.0	39.0	39.0
Actual Transit Draft at 43 Feet	40.0	40.0	40.0
Actual Transit Draft at 44 Feet	41.0	41.0	41.0
Actual Transit Draft at 45 Feet	42.0	42.0	42.0
Actual Transit Draft at 46 Feet	43.0	43.0	43.0
Actual Transit Draft at 47 Feet	44.0	44.0	44.0
Actual Transit Draft at 48 Feet	45.0	45.0	45.0
Actual Transit Draft at 49 Feet	46.0	46.0	46.0
Actual Transit Draft at 50 Feet	46.0	46.0	46.0
Lading at 42 Feet	45,759	45,759	45,759
Lading at 43 Feet	48,204	48,204	48,204
Lading at 44 Feet	50,648	50,648	50,648
Lading at 45 Feet	53,092	53,092	53,092
Lading at 46 Feet	55,536	55,536	55,536
Lading at 47 Feet	57,980	57,980	57,980
Lading at 48 Feet	60,424	60,424	60,424
Lading at 49 Feet	62,869	62,869	62,869
Lading at 50 Feet	62,869	62,869	62,869
Total Transit Weight - 42 Feet	54,104	54,104	54,104
Total Transit Weight - 43 Feet	56,548	56,548	56,548
Total Transit Weight - 44 Feet	58,992	58,992	58,992
Total Transit Weight - 45 Feet	61,436	61,436	61,436
Total Transit Weight - 46 Feet	63,881	63,881	63,881
Total Transit Weight - 47 Feet	66,325	66,325	66,325
Total Transit Weight - 48 Feet	68,769	68,769	68,769
Total Transit Weight - 49 Feet	71,213	71,213	71,213
Total Transit Weight - 50 Feet	71,213	71,213	71,213

Table A-39: Channel or Canal Restraint, Applied Maximum Transit Depth, Actual Transit Draft, Lading in Short Tons, and Total Transit Weight in Short Tons for Outbound Composite Other Post-Panamax Container Vessels at Miami Harbor

	Composite Other Post-Panamax - Far East Trade Region	**Composite Other Post-Panamax - Europe Trade Region**	**Composite Other Post-Panamax - Mediterranean Trade Region**
Channel or Canal Restraint	U.S. East Coast Port	Southampton, England	Valletta, Malta
Channel Constraint at Port of Origin or Canal Restraint (Feet)	49.0	49.2	50.6
Actual Transit Draft at 42 Feet	39.0	39.0	39.0
Actual Transit Draft at 43 Feet	40.0	40.0	40.0
Actual Transit Draft at 44 Feet	41.0	41.0	41.0
Actual Transit Draft at 45 Feet	42.0	42.0	42.0
Actual Transit Draft at 46 Feet	43.0	43.0	43.0
Actual Transit Draft at 47 Feet	44.0	44.0	44.0
Actual Transit Draft at 48 Feet	45.0	45.0	45.0
Actual Transit Draft at 49 Feet	46.0	46.0	46.0
Actual Transit Draft at 50 Feet	46.0	46.0	46.0
Lading at 42 Feet	45,759	45,759	45,759
Lading at 43 Feet	48,204	48,204	48,204
Lading at 44 Feet	50,648	50,648	50,648
Lading at 45 Feet	53,092	53,092	53,092
Lading at 46 Feet	55,536	55,536	55,536
Lading at 47 Feet	57,980	57,980	57,980
Lading at 48 Feet	60,424	60,424	60,424
Lading at 49 Feet	62,869	62,869	62,869
Lading at 50 Feet	62,869	62,869	62,869
Total Transit Weight - 42 Feet	54,104	54,104	54,104
Total Transit Weight - 43 Feet	56,548	56,548	56,548
Total Transit Weight - 44 Feet	58,992	58,992	58,992
Total Transit Weight - 45 Feet	61,436	61,436	61,436
Total Transit Weight - 46 Feet	63,881	63,881	63,881
Total Transit Weight - 47 Feet	66,325	66,325	66,325
Total Transit Weight - 48 Feet	68,769	68,769	68,769
Total Transit Weight - 49 Feet	71,213	71,213	71,213
Total Transit Weight - 50 Feet	71,213	71,213	71,213

Table A-40: Channel or Canal Restraint, Applied Maximum Transit Depth, Actual Transit Draft, Lading in Short Tons, and Total Transit Weight in Short Tons for Inbound Madison Maersk at Miami Harbor

	Madison Maersk (Panamax) - Far East Trade Region	**Madison Maersk (Panamax) - Europe Trade Region**	**Madison Maersk (Panamax) - Mediterranean Trade Region**
Channel or Canal Restraint	Panama Canal	U.S. East Coast Port	U.S. East Coast Port
Channel Constraint at Port of Origin or Canal Restraint (Feet)	39.0	49.0	49.0
Applied Maximum Transit Depth	39.0	45.4	45.4
Actual Transit Draft at 42 Feet	36.0	39.0	39.0
Actual Transit Draft at 43 Feet	36.0	40.0	40.0
Actual Transit Draft at 44 Feet	36.0	41.0	41.0
Actual Transit Draft at 45 Feet	36.0	42.0	42.0
Actual Transit Draft at 46 Feet	36.0	42.4	42.4
Actual Transit Draft at 47 Feet	36.0	42.4	42.4
Actual Transit Draft at 48 Feet	36.0	42.4	42.4
Actual Transit Draft at 49 Feet	36.0	42.4	42.4
Actual Transit Draft at 50 Feet	36.0	42.4	42.4
Lading at 42 Feet	39,159	46,027	46,027
Lading at 43 Feet	39,159	48,316	48,316
Lading at 44 Feet	39,159	50,606	50,606
Lading at 45 Feet	39,159	52,895	52,895
Lading at 46 Feet	39,159	53,781	53,781
Lading at 47 Feet	39,159	53,781	53,781
Lading at 48 Feet	39,159	53,781	53,781
Lading at 49 Feet	39,159	53,781	53,781
Lading at 50 Feet	39,159	53,781	53,781
Total Transit Weight - 42 Feet	47,393	54,261	54,261
Total Transit Weight - 43 Feet	47,393	56,550	56,550
Total Transit Weight - 44 Feet	47,393	58,840	58,840
Total Transit Weight - 45 Feet	47,393	61,129	61,129
Total Transit Weight - 46 Feet	47,393	62,015	62,015
Total Transit Weight - 47 Feet	47,393	62,015	62,015
Total Transit Weight - 48 Feet	47,393	62,015	62,015
Total Transit Weight - 49 Feet	47,393	62,015	62,015
Total Transit Weight - 50 Feet	47,393	62,015	62,015

Table A-41: Channel or Canal Restraint, Applied Maximum Transit Depth, Actual Transit Draft, Lading in Short Tons, and Total Transit Weight in Short Tons for Outbound Madison Maersk at Miami Harbor

	Madison Maersk (Panamax) - Far East Trade Region	**Madison Maersk (Panamax) - Europe Trade Region**	**Madison Maersk (Panamax) - Mediterranean Trade Region**
Channel or Canal Restraint	U.S. East Coast Port	Southampton, England	Valletta, Malta
Channel Constraint at Port of Origin or Canal Restraint (Feet)	49.0	49.2	50.6
Actual Transit Draft at 42 Feet	39.0	39.0	39.0
Actual Transit Draft at 43 Feet	40.0	40.0	40.0
Actual Transit Draft at 44 Feet	41.0	41.0	41.0
Actual Transit Draft at 45 Feet	42.0	42.0	42.0
Actual Transit Draft at 46 Feet	42.4	42.4	42.4
Actual Transit Draft at 47 Feet	42.4	42.4	42.4
Actual Transit Draft at 48 Feet	42.4	42.4	42.4
Actual Transit Draft at 49 Feet	42.4	42.4	42.4
Actual Transit Draft at 50 Feet	42.4	42.4	42.4
Lading at 42 Feet	46,027	46,027	46,027
Lading at 43 Feet	48,316	48,316	48,316
Lading at 44 Feet	50,606	50,606	50,606
Lading at 45 Feet	52,895	52,895	52,895
Lading at 46 Feet	53,781	53,781	53,781
Lading at 47 Feet	53,781	53,781	53,781
Lading at 48 Feet	53,781	53,781	53,781
Lading at 49 Feet	53,781	53,781	53,781
Lading at 50 Feet	53,781	53,781	53,781
Total Transit Weight - 42 Feet	54,261	54,261	54,261
Total Transit Weight - 43 Feet	56,550	56,550	56,550
Total Transit Weight - 44 Feet	58,840	58,840	58,840
Total Transit Weight - 45 Feet	61,129	61,129	61,129
Total Transit Weight - 46 Feet	62,015	62,015	62,015
Total Transit Weight - 47 Feet	62,015	62,015	62,015
Total Transit Weight - 48 Feet	62,015	62,015	62,015
Total Transit Weight - 49 Feet	62,015	62,015	62,015
Total Transit Weight - 50 Feet	62,015	62,015	62,015

Table A-42: Channel or Canal Restraint, Applied Maximum Transit Depth, Actual Transit Draft, Lading in Short Tons, and Total Transit Weight in Short Tons for Inbound Zim Asia at Miami Harbor

	Zim Asia (Sub-Panamax) - Far East Trade Region	**Zim Asia (Sub-Panamax) - Europe Trade Region**	**Zim Asia (Sub-Panamax) - Mediterranean Trade Region**
Channel or Canal Restraint	Panama Canal	U.S. East Coast Port	U.S. East Coast Port
Channel Constraint at Port of Origin or Canal Restraint (Feet)	39.0	49.0	49.0
Applied Maximum Transit Depth	39.0	41.6	41.6
Actual Transit Draft at 42 Feet	36.0	38.6	38.6
Actual Transit Draft at 43 Feet	36.0	38.6	38.6
Actual Transit Draft at 44 Feet	36.0	38.6	38.6
Actual Transit Draft at 45 Feet	36.0	38.6	38.6
Actual Transit Draft at 46 Feet	36.0	38.6	38.6
Actual Transit Draft at 47 Feet	36.0	38.6	38.6
Actual Transit Draft at 48 Feet	36.0	38.6	38.6
Actual Transit Draft at 49 Feet	36.0	38.6	38.6
Actual Transit Draft at 50 Feet	36.0	38.6	38.6
Lading at 42 Feet	41,674	46,639	46,639
Lading at 43 Feet	41,674	46,639	46,639
Lading at 44 Feet	41,674	46,639	46,639
Lading at 45 Feet	41,674	46,639	46,639
Lading at 46 Feet	41,674	46,639	46,639
Lading at 47 Feet	41,674	46,639	46,639
Lading at 48 Feet	41,674	46,639	46,639
Lading at 49 Feet	41,674	46,639	46,639
Lading at 50 Feet	41,674	46,639	46,639
Total Transit Weight - 42 Feet	48,258	53,222	53,222
Total Transit Weight - 43 Feet	48,258	53,222	53,222
Total Transit Weight - 44 Feet	48,258	53,222	53,222
Total Transit Weight - 45 Feet	48,258	53,222	53,222
Total Transit Weight - 46 Feet	48,258	53,222	53,222
Total Transit Weight - 47 Feet	48,258	53,222	53,222
Total Transit Weight - 48 Feet	48,258	53,222	53,222
Total Transit Weight - 49 Feet	48,258	53,222	53,222
Total Transit Weight - 50 Feet	48,258	53,222	53,222

Table A-43: Channel or Canal Restraint, Applied Maximum Transit Depth, Actual Transit Draft, Lading in Short Tons, and Total Transit Weight in Short Tons for Outbound Zim Asia at Miami Harbor

	Zim Asia (Sub-Panamax) - Far East Trade Region	Zim Asia (Sub-Panamax) - Europe Trade Region	Zim Asia (Sub-Panamax) - Mediterranean Trade Region
Channel or Canal Restraint	U.S. East Coast Port	Southampton, England	Valletta, Malta
Channel Constraint at Port of Origin or Canal Restraint (Feet)	49.0	49.2	50.6
Actual Transit Draft at 42 Feet	38.6	38.6	38.6
Actual Transit Draft at 43 Feet	38.6	38.6	38.6
Actual Transit Draft at 44 Feet	38.6	38.6	38.6
Actual Transit Draft at 45 Feet	38.6	38.6	38.6
Actual Transit Draft at 46 Feet	38.6	38.6	38.6
Actual Transit Draft at 47 Feet	38.6	38.6	38.6
Actual Transit Draft at 48 Feet	38.6	38.6	38.6
Actual Transit Draft at 49 Feet	38.6	38.6	38.6
Actual Transit Draft at 50 Feet	38.6	38.6	38.6
Lading at 42 Feet	46,639	46,639	46,639
Lading at 43 Feet	46,639	46,639	46,639
Lading at 44 Feet	46,639	46,639	46,639
Lading at 45 Feet	46,639	46,639	46,639
Lading at 46 Feet	46,639	46,639	46,639
Lading at 47 Feet	46,639	46,639	46,639
Lading at 48 Feet	46,639	46,639	46,639
Lading at 49 Feet	46,639	46,639	46,639
Lading at 50 Feet	46,639	46,639	46,639
Total Transit Weight - 42 Feet	53,222	53,222	53,222
Total Transit Weight - 43 Feet	53,222	53,222	53,222
Total Transit Weight - 44 Feet	53,222	53,222	53,222
Total Transit Weight - 45 Feet	53,222	53,222	53,222
Total Transit Weight - 46 Feet	53,222	53,222	53,222
Total Transit Weight - 47 Feet	53,222	53,222	53,222
Total Transit Weight - 48 Feet	53,222	53,222	53,222
Total Transit Weight - 49 Feet	53,222	53,222	53,222
Total Transit Weight - 50 Feet	53,222	53,222	53,222

Number of Calls and Total Tonnage Transported

The analysis predicts a gradual transition to larger vessels for the life of the project in both the without- and with-project conditions. The assumed distribution of calls for each year of the project is a function of the distribution of calls that actually occurred in 1999. In the first year of the project, approximately four percent of the predicted calls are by Post-Panamax vessels, with a corresponding reduction in the number of Panamax vessel calls; Panamax vessels replace Sub-Panamax vessels at the same rate. The net effect is no change in the number of Panamax vessel calls, and a reduction in the number of Sub-Panamax vessel calls. The number of Post-Panamax vessel calls increases in a straight-line fashion until year 50 of the project when these calls represent approximately 77 percent of the predicted calls; in the year range 36-40, the Sub-Panamax vessel class disappears from the predicted calls and the additional Post-Panamax vessels begin replacing Panamax vessels instead.

Post-Panamax vessel calls are equally distributed among the three Post-Panamax vessel classes for each year range. **Table A-44** displays the distribution of predicted vessel calls for the life of the project. **Table A-45** displays the actual predicted vessel calls for each vessel class for the life of the project, based on the predicted distribution of calls, the capacity of each vessel class, and the predicted tonnage for each year range.

Table A-44: Expected Percentage of Calls by Vessel Class for the Life of the Project in Both the Without-Project and With-Project Conditions

Project Year	Susan Maersk (Post-Panamax) Percentage of Calls	Regina Maersk (Post-Panamax) Percentage of Calls	Composite Other Post-Panamax Percentage of Calls	Madison Maersk (Panamax) Percentage of Calls	Zim Asia (Sub-Panamax) Percentage of Calls
2002	0%	0%	0%	45%	55%
Years 1 - 5	1%	1%	1%	45%	51%
Years 6 - 10	4%	4%	4%	45%	43%
Years 11 - 15	7%	7%	7%	45%	35%
Years 16 - 20	9%	9%	9%	45%	27%
Years 21 - 25	12%	12%	12%	45%	19%
Years 26 - 30	15%	15%	15%	45%	11%
Years 31 - 35	18%	18%	18%	45%	2%
Years 36 - 40	20%	20%	20%	39%	0%
Years 41 - 45	23%	23%	23%	31%	0%
Years 46 - 50	26%	26%	26%	23%	0%

Table A-45: Expected Total Calls by Vessel Class for the Life of the Project in Both the Without-Project and With-Project Conditions

Project Year	Susan Maersk (Post-Panamax) Predicted Calls	Regina Maersk (Post-Panamax) Predicted Calls	Composite Other Post-Panamax Predicted Calls	Madison Maersk (Panamax) Predicted Calls	Zim Asia (Sub-Panamax) Predicted Calls
Years 1 - 5	4	4	4	141	162
Years 6 - 10	15	15	15	178	172
Years 11 - 15	38	38	38	249	195
Years 16 - 20	71	71	71	338	203
Years 21 - 25	118	118	118	444	186
Years 26 - 30	176	176	176	529	126
Years 31 - 35	246	246	246	631	36
Years 36 - 40	337	337	337	660	0
Years 41 - 45	463	463	463	625	0
Years 46 - 50	614	614	614	553	0

The number of predicted calls for each vessel class times the capacity of each vessel class at each channel depth for the inbound and outbound transit results in a yearly capacity by vessel class for the inbound and outbound transit. The predicted inbound yearly capacities of each vessel class at each depth are shown in **Tables A-46** to **A-54**.

Table A-46: Capacities of Inbound Fleet in Short Tons by Vessel Class and Project Year at 42 Feet of Channel Depth

Project Year	Susan Maersk (Post-Panamax) Total Capacity	Regina Maersk (Post-Panamax) Total Capacity	Composite Other Post-Panamax Total Capacity	Madison Maersk (Panamax) Total Capacity	Zim Asia (Sub-Panamax) Total Capacity
Years 1 - 5	241,564	234,811	183,037	5,521,373	5,000,937
Years 6 - 10	905,865	880,543	686,390	6,970,244	4,209,122
Years 11 - 15	2,294,857	2,230,708	1,738,854	9,750,510	3,417,307
Years 16 - 20	4,287,760	4,167,902	3,248,912	13,235,633	2,625,492
Years 21 - 25	7,126,136	6,926,936	5,399,601	17,386,452	1,833,677
Years 26 - 30	10,628,814	10,331,701	8,053,642	20,714,940	1,041,862
Years 31 - 35	14,856,183	14,440,900	11,256,795	24,709,125	250,047
Years 36 - 40	20,351,762	19,782,858	15,420,893	25,844,726	0
Years 41 - 45	27,961,027	27,179,417	21,186,569	24,474,173	0
Years 46 - 50	37,080,066	36,043,546	28,096,227	21,654,748	0

Table A-47: Capacities of Inbound Fleet in Short Tons by Vessel Class and Project Year at 43 Feet of Channel Depth

Project Year	Susan Maersk (Post-Panamax) Total Capacity	Regina Maersk (Post-Panamax) Total Capacity	Composite Other Post-Panamax Total Capacity	Madison Maersk (Panamax) Total Capacity	Zim Asia (Sub-Panamax) Total Capacity
Years 1 - 5	256,935	247,157	192,814	5,521,373	6,751,265
Years 6 - 10	963,505	926,839	723,053	6,970,244	7,168,009
Years 11 - 15	2,440,879	2,347,991	1,831,733	9,750,510	8,126,522
Years 16 - 20	4,560,591	4,387,036	3,422,449	13,235,633	8,459,918
Years 21 - 25	7,579,573	7,291,130	5,688,014	17,386,452	7,751,452
Years 26 - 30	11,305,126	10,874,905	8,483,818	20,714,940	5,250,984
Years 31 - 35	15,801,483	15,200,152	11,858,064	24,709,125	1,500,281
Years 36 - 40	21,646,747	20,822,972	16,244,584	25,844,726	0
Years 41 - 45	29,740,189	28,608,416	22,318,226	24,474,173	0
Years 46 - 50	39,439,473	37,938,590	29,596,956	21,654,748	0

Table A-48: Capacities of Inbound Fleet in Short Tons by Vessel Class and Project Year at 44 Feet of Channel Depth

Project Year	Susan Maersk (Post-Panamax) Total Capacity	Regina Maersk (Post-Panamax) Total Capacity	Composite Other Post-Panamax Total Capacity	Madison Maersk (Panamax) Total Capacity	Zim Asia (Sub-Panamax) Total Capacity
Years 1 - 5	272,305	259,503	202,591	5,521,373	6,751,265
Years 6 - 10	1,021,145	973,134	759,715	6,970,244	7,168,009
Years 11 - 15	2,586,901	2,465,274	1,924,612	9,750,510	8,126,522
Years 16 - 20	4,833,421	4,606,169	3,595,986	13,235,633	8,459,918
Years 21 - 25	8,033,010	7,655,324	5,976,428	17,386,452	7,751,452
Years 26 - 30	11,981,438	11,418,110	8,913,995	20,714,940	5,250,984
Years 31 - 35	16,746,783	15,959,404	12,459,333	24,709,125	1,500,281
Years 36 - 40	22,941,731	21,863,086	17,068,274	25,844,726	0
Years 41 - 45	31,519,351	30,037,414	23,449,883	24,474,173	0
Years 46 - 50	41,798,880	39,833,634	31,097,685	21,654,748	0

Table A-49: Capacities of Inbound Fleet in Short Tons by Vessel Class and Project Year at 45 Feet of Channel Depth

Project Year	Susan Maersk (Post-Panamax) Total Capacity	Regina Maersk (Post-Panamax) Total Capacity	Composite Other Post-Panamax Total Capacity	Madison Maersk (Panamax) Total Capacity	Zim Asia (Sub-Panamax) Total Capacity
Years 1 - 5	287,676	271,848	212,368	5,521,373	6,751,265
Years 6 - 10	1,078,786	1,019,430	796,378	6,970,244	7,168,009
Years 11 - 15	2,732,923	2,582,557	2,017,491	9,750,510	8,126,522
Years 16 - 20	5,106,252	4,825,303	3,769,524	13,235,633	8,459,918
Years 21 - 25	8,486,446	8,019,518	6,264,842	17,386,452	7,751,452
Years 26 - 30	12,657,750	11,961,315	9,344,171	20,714,940	5,250,984
Years 31 - 35	17,692,083	16,718,656	13,060,603	24,709,125	1,500,281
Years 36 - 40	24,236,715	22,903,199	17,891,964	25,844,726	0
Years 41 - 45	33,298,513	31,466,413	24,581,541	24,474,173	0
Years 46 - 50	44,158,288	41,728,678	32,598,415	21,654,748	0

Table A-50: Capacities of Inbound Fleet in Short Tons by Vessel Class and Project Year at 46 Feet of Channel Depth

Project Year	Susan Maersk (Post-Panamax) Total Capacity	Regina Maersk (Post-Panamax) Total Capacity	Composite Other Post-Panamax Total Capacity	Madison Maersk (Panamax) Total Capacity	Zim Asia (Sub-Panamax) Total Capacity
Years 1 - 5	303,047	284,194	222,144	5,521,373	6,751,265
Years 6 - 10	1,136,426	1,065,726	833,041	6,970,244	7,168,009
Years 11 - 15	2,878,945	2,699,839	2,110,370	9,750,510	8,126,522
Years 16 - 20	5,379,082	5,044,437	3,943,061	13,235,633	8,459,918
Years 21 - 25	8,939,883	8,383,712	6,553,256	17,386,452	7,751,452
Years 26 - 30	13,334,062	12,504,520	9,774,347	20,714,940	5,250,984
Years 31 - 35	18,637,383	17,477,908	13,661,872	24,709,125	1,500,281
Years 36 - 40	25,531,699	23,943,313	18,715,654	25,844,726	0
Years 41 - 45	35,077,676	32,895,412	25,713,198	24,474,173	0
Years 46 - 50	46,517,695	43,623,722	34,099,144	21,654,748	0

Table A-51: Capacities of Inbound Fleet in Short Tons by Vessel Class and Project Year at 47 Feet of Channel Depth

Project Year	Susan Maersk (Post-Panamax) Total Capacity	Regina Maersk (Post-Panamax) Total Capacity	Composite Other Post-Panamax Total Capacity	Madison Maersk (Panamax) Total Capacity	Zim Asia (Sub-Panamax) Total Capacity
Years 1 - 5	318,418	296,539	231,921	5,521,373	6,751,265
Years 6 - 10	1,194,066	1,112,022	869,704	6,970,244	7,168,009
Years 11 - 15	3,024,967	2,817,122	2,203,249	9,750,510	8,126,522
Years 16 - 20	5,651,913	5,263,571	4,116,598	13,235,633	8,459,918
Years 21 - 25	9,393,319	8,747,906	6,841,669	17,386,452	7,751,452
Years 26 - 30	14,010,375	13,047,724	10,204,524	20,714,940	5,250,984
Years 31 - 35	19,582,683	18,237,160	14,263,141	24,709,125	1,500,281
Years 36 - 40	26,826,683	24,983,427	19,539,344	25,844,726	0
Years 41 - 45	36,856,838	34,324,411	26,844,855	24,474,173	0
Years 46 - 50	48,877,103	45,518,765	35,599,873	21,654,748	0

Table A-52: Capacities of Inbound Fleet in Short Tons by Vessel Class and Project Year at 48 Feet of Channel Depth

Project Year	Susan Maersk (Post-Panamax) Total Capacity	Regina Maersk (Post-Panamax) Total Capacity	Composite Other Post-Panamax Total Capacity	Madison Maersk (Panamax) Total Capacity	Zim Asia (Sub-Panamax) Total Capacity
Years 1 - 5	333,788	308,885	241,698	5,521,373	6,751,265
Years 6 - 10	1,251,706	1,158,318	906,366	6,970,244	7,168,009
Years 11 - 15	3,170,989	2,934,405	2,296,128	9,750,510	8,126,522
Years 16 - 20	5,924,743	5,482,704	4,290,135	13,235,633	8,459,918
Years 21 - 25	9,846,756	9,112,100	7,130,083	17,386,452	7,751,452
Years 26 - 30	14,686,687	13,590,929	10,634,700	20,714,940	5,250,984
Years 31 - 35	20,527,983	18,996,412	14,864,410	24,709,125	1,500,281
Years 36 - 40	28,121,668	26,023,540	20,363,034	25,844,726	0
Years 41 - 45	38,636,000	35,753,410	27,976,512	24,474,173	0
Years 46 - 50	51,236,510	47,413,809	37,100,602	21,654,748	0

Table A-53: Capacities of Inbound Fleet in Short Tons by Vessel Class and Project Year at 49 Feet of Channel Depth

Project Year	Susan Maersk (Post-Panamax) Total Capacity	Regina Maersk (Post-Panamax) Total Capacity	Composite Other Post-Panamax Total Capacity	Madison Maersk (Panamax) Total Capacity	Zim Asia (Sub-Panamax) Total Capacity
Years 1 - 5	349,159	319,996	251,474	5,521,373	6,751,265
Years 6 - 10	1,309,347	1,199,984	943,029	6,970,244	7,168,009
Years 11 - 15	3,317,011	3,039,960	2,389,007	9,750,510	8,126,522
Years 16 - 20	6,197,574	5,679,925	4,463,672	13,235,633	8,459,918
Years 21 - 25	10,300,193	9,439,875	7,418,497	17,386,452	7,751,452
Years 26 - 30	15,362,999	14,079,813	11,064,877	20,714,940	5,250,984
Years 31 - 35	21,473,283	19,679,739	15,465,680	24,709,125	1,500,281
Years 36 - 40	29,416,652	26,959,643	21,186,724	25,844,726	0
Years 41 - 45	40,415,163	37,039,509	29,108,170	24,474,173	0
Years 46 - 50	53,595,918	49,119,349	38,601,331	21,654,748	0

Table A-54: Capacities of Inbound Fleet in Short Tons by Vessel Class and Project Year at 50 Feet of Channel Depth

Project Year	Susan Maersk (Post-Panamax) Total Capacity	Regina Maersk (Post-Panamax) Total Capacity	Composite Other Post-Panamax Total Capacity	Madison Maersk (Panamax) Total Capacity	Zim Asia (Sub-Panamax) Total Capacity
Years 1 - 5	352,030	319,996	251,474	5,521,373	6,751,265
Years 6 - 10	1,320,113	1,199,984	943,029	6,970,244	7,168,009
Years 11 - 15	3,344,287	3,039,960	2,389,007	9,750,510	8,126,522
Years 16 - 20	6,248,536	5,679,925	4,463,672	13,235,633	8,459,918
Years 21 - 25	10,384,890	9,439,875	7,418,497	17,386,452	7,751,452
Years 26 - 30	15,489,328	14,079,813	11,064,877	20,714,940	5,250,984
Years 31 - 35	21,649,856	19,679,739	15,465,680	24,709,125	1,500,281
Years 36 - 40	29,658,542	26,959,643	21,186,724	25,844,726	0
Years 41 - 45	40,747,493	37,039,509	29,108,170	24,474,173	0
Years 46 - 50	54,036,632	49,119,349	38,601,331	21,654,748	0

The yearly import capacities of the vessel classes are expressed in **Tables A-55 to A-63** as percentages of the total yearly capacity of the entire fleet. For use in the analysis, export capacities were also calculated.

Table A-55: Percentage of Import Capacity at 42 Feet of Channel Depth by Vessel Class and Project Year at Miami Harbor

Susan Maersk (Post-Panamax) Share of Tonnage	Regina Maersk (Post-Panamax) Share of Tonnage	Composite Other Post-Panamax Share of Tonnage	Madison Maersk (Panamax) Share of Tonnage	Zim Asia (Sub-Panamax) Share of Tonnage
2%	2%	2%	49%	45%
7%	6%	5%	51%	31%
12%	11%	9%	50%	18%
16%	15%	12%	48%	10%
18%	18%	14%	45%	5%
21%	20%	16%	41%	2%
23%	22%	17%	38%	0%
25%	24%	19%	32%	0%
28%	27%	21%	24%	0%
30%	29%	23%	18%	0%

Table A-56: Percentage of Import Capacity at 43 Feet of Channel Depth by Vessel Class and Project Year at Miami Harbor

Susan Maersk (Post-Panamax) Share of Tonnage	Regina Maersk (Post-Panamax) Share of Tonnage	Composite Other Post-Panamax Share of Tonnage	Madison Maersk (Panamax) Share of Tonnage	Zim Asia (Sub-Panamax) Share of Tonnage
2%	2%	1%	43%	52%
6%	6%	4%	42%	43%
10%	10%	7%	40%	33%
13%	13%	10%	39%	25%
17%	16%	12%	38%	17%
20%	19%	15%	37%	9%
23%	22%	17%	36%	2%
26%	25%	19%	31%	0%
28%	27%	21%	23%	0%
31%	29%	23%	17%	0%

Table A-57: Percentage of Import Capacity at 44 Feet of Channel Depth by Vessel Class and Project Year at Miami Harbor

Susan Maersk (Post-Panamax) Share of Tonnage	Regina Maersk (Post-Panamax) Share of Tonnage	Composite Other Post-Panamax Share of Tonnage	Madison Maersk (Panamax) Share of Tonnage	Zim Asia (Sub-Panamax) Share of Tonnage
2%	2%	2%	42%	52%
6%	6%	4%	41%	42%
10%	10%	8%	39%	33%
14%	13%	10%	38%	24%
17%	16%	13%	37%	17%
21%	20%	15%	36%	9%
23%	22%	17%	35%	2%
26%	25%	19%	29%	0%
29%	27%	21%	22%	0%
31%	30%	23%	16%	0%

Table A-58: Percentage of Import Capacity at 45 Feet of Channel Depth by Vessel Class and Project Year at Miami Harbor

Susan Maersk (Post-Panamax) Share of Tonnage	Regina Maersk (Post-Panamax) Share of Tonnage	Composite Other Post-Panamax Share of Tonnage	Madison Maersk (Panamax) Share of Tonnage	Zim Asia (Sub-Panamax) Share of Tonnage
2%	2%	2%	42%	52%
6%	6%	5%	41%	42%
11%	10%	8%	39%	32%
14%	14%	11%	37%	24%
18%	17%	13%	36%	16%
21%	20%	16%	35%	9%
24%	23%	18%	34%	2%
27%	25%	20%	28%	0%
29%	28%	22%	22%	0%
32%	30%	23%	15%	0%

Table A-59: Percentage of Import Capacity at 46 Feet of Channel Depth by Vessel Class and Project Year at Miami Harbor

Susan Maersk (Post-Panamax) Share of Tonnage	Regina Maersk (Post-Panamax) Share of Tonnage	Composite Other Post-Panamax Share of Tonnage	Madison Maersk (Panamax) Share of Tonnage	Zim Asia (Sub-Panamax) Share of Tonnage
2%	2%	2%	42%	52%
7%	6%	5%	41%	42%
11%	11%	8%	38%	32%
15%	14%	11%	37%	23%
18%	17%	13%	35%	16%
22%	20%	16%	34%	9%
25%	23%	18%	33%	2%
27%	25%	20%	27%	0%
30%	28%	22%	21%	0%
32%	30%	23%	15%	0%

Table A-60: Percentage of Import Capacity at 47 Feet of Channel Depth by Vessel Class and Project Year at Miami Harbor

Susan Maersk (Post-Panamax) Share of Tonnage	Regina Maersk (Post-Panamax) Share of Tonnage	Composite Other Post-Panamax Share of Tonnage	Madison Maersk (Panamax) Share of Tonnage	Zim Asia (Sub-Panamax) Share of Tonnage
2%	2%	2%	42%	51%
7%	6%	5%	40%	41%
12%	11%	8%	38%	31%
15%	14%	11%	36%	23%
19%	17%	14%	35%	15%
22%	21%	16%	33%	8%
25%	23%	18%	32%	2%
28%	26%	20%	27%	0%
30%	28%	22%	20%	0%
32%	30%	23%	14%	0%

Table A-61: Percentage of Import Capacity at 48 Feet of Channel Depth by Vessel Class and Project Year at Miami Harbor

Susan Maersk (Post-Panamax) Share of Tonnage	Regina Maersk (Post-Panamax) Share of Tonnage	Composite Other Post-Panamax Share of Tonnage	Madison Maersk (Panamax) Share of Tonnage	Zim Asia (Sub-Panamax) Share of Tonnage
3%	2%	2%	42%	51%
7%	7%	5%	40%	41%
12%	11%	9%	37%	31%
16%	15%	11%	35%	23%
19%	18%	14%	34%	15%
23%	21%	16%	32%	8%
25%	24%	18%	31%	2%
28%	26%	20%	26%	0%
30%	28%	22%	19%	0%
33%	30%	24%	14%	0%

Table A-62: Percentage of Import Capacity at 49 Feet of Channel Depth by Vessel Class and Project Year at Miami Harbor

Susan Maersk (Post-Panamax) Share of Tonnage	Regina Maersk (Post-Panamax) Share of Tonnage	Composite Other Post-Panamax Share of Tonnage	Madison Maersk (Panamax) Share of Tonnage	Zim Asia (Sub-Panamax) Share of Tonnage
3%	2%	2%	42%	51%
7%	7%	5%	40%	41%
12%	11%	9%	37%	31%
16%	15%	12%	35%	22%
20%	18%	14%	33%	15%
23%	21%	17%	31%	8%
26%	24%	19%	30%	2%
28%	26%	20%	25%	0%
31%	28%	22%	19%	0%
33%	30%	24%	13%	0%

Table A-63: Percentage of Import Capacity at 50 Feet of Channel Depth by Vessel Class and Project Year at Miami Harbor

Susan Maersk (Post-Panamax) Share of Tonnage	Regina Maersk (Post-Panamax) Share of Tonnage	Composite Other Post-Panamax Share of Tonnage	Madison Maersk (Panamax) Share of Tonnage	Zim Asia (Sub-Panamax) Share of Tonnage
3%	2%	2%	42%	51%
8%	7%	5%	40%	41%
13%	11%	9%	37%	30%
16%	15%	12%	35%	22%
20%	18%	14%	33%	15%
23%	21%	17%	31%	8%
26%	24%	19%	30%	2%
29%	26%	20%	25%	0%
31%	28%	22%	19%	0%
33%	30%	24%	13%	0%

Hourly Operating Costs, Trip Distance, and Total Voyage Cost

Hourly operating costs are based on standard at-sea and in-port vessel operating costs for vessel types categorized by deadweight. The standard costs are found in an economic guidance memorandum published and updated annually by the Corps' Institute for Water Resources (IWR). Regression analysis is used to estimate the hourly operating costs for vessels calling at each terminal by relating their deadweight values to those used by the IWR.

Trip distances are calculated for the inbound and the outbound voyages for each itinerary. These distances, the vessels' speeds, and the vessels' hourly operating costs at sea are used to determine the total voyage cost for the inbound and outbound voyages. The product of the fixed time spent at berth and the vessels' hourly operating costs in port are added to generate the total costs for the inbound and outbound transits.

Table A-64 and **Table A-65** display the trip distances and total voyage costs for each vessel class's inbound and outbound transit.

Table A-64: Trip Distances and Total Voyage Costs for Inbound Transits to Miami Harbor by Vessel Class

	Inbound Susan Maersk (Post-Panamax)	Inbound Regina Maersk (Post-Panamax)	Inbound Composite Other Post-Panamax	Inbound Madison Maersk (Panamax)	Inbound Zim Asia (Sub-Panamax)
Applicable trip Distance - Far East	12,221	12,221	12,221	10,448	10,448
Applicable trip Distance - Europe	4,189	4,189	4,189	4,189	4,189
Applicable trip Distance - Mediterranean	5,201	5,201	5,201	5,201	5,201
Speed (Knots per Hour)	24.6	25.0	25.5	24.0	21.7
Vessel Operating Cost at Sea	$2,945	$2,439	$1,993	$1,970	$1,563
Transit Cost - Far East	$1,692,748	$1,422,375	$1,187,032	$932,140	$826,661
Transit Cost - Europe	$501,427	$408,751	$328,082	$343,926	$301,636
Transit Cost - Mediterranean	$622,565	$507,499	$407,342	$427,014	$374,507
Fixed Time at Berth	2	2	2	2	2
Vessel Operating Cost at Berth	$1,586	$1,342	$1,127	$1,116	$919
Time at Berth Cost	$3,172	$2,684	$2,253	$2,231	$1,837
Total Voyage Cost - Far East	$1,695,920	$1,425,059	$1,189,285	$934,371	$828,498
Total Voyage Cost - Europe	$504,599	$411,435	$330,335	$346,158	$303,473
Total Voyage Cost - Mediterranean	$625,736	$510,183	$409,595	$429,245	$376,344

Table A-65: Trip Distances and Total Voyage Costs for Outbound Transits from Miami Harbor by Vessel Class

	Outbound Susan Maersk (Post-Panamax)	Outbound Regina Maersk (Post-Panamax)	Outbound Composite Other Post-Panamax	Outbound Madison Maersk (Panamax)	Outbound Zim Asia (Sub-Panamax)
Applicable trip Distance - Far East	12,636	12,636	12,636	12,233	12,233
Applicable trip Distance - Europe	3,866	3,866	3,866	3,866	3,866
Applicable trip Distance - Mediterranean	4,786	4,786	4,786	4,786	4,786
Speed (Knots per Hour)	24.6	25.0	25.5	24.0	21.7
Vessel Operating Cost at Sea	$2,945	$2,439	$1,993	$1,970	$1,563
Transit Cost - Far East	$1,512,541	$1,232,986	$989,651	$1,004,357	$880,858
Transit Cost - Europe	$462,764	$377,234	$302,785	$317,407	$278,378
Transit Cost - Mediterranean	$572,889	$467,005	$374,839	$392,942	$344,624
Fixed Time at Berth	2	2	2	2	2
Vessel Operating Cost at Berth	$1,586	$1,342	$1,127	$1,116	$919
Time at Berth Cost	$3,172	$2,684	$2,253	$2,231	$1,837
Total Voyage Cost - Far East	$1,515,713	$1,235,670	$991,904	$1,006,588	$882,695
Total Voyage Cost - Europe	$465,936	$379,918	$305,038	$319,638	$280,215
Total Voyage Cost - Mediterranean	$576,060	$469,689	$377,092	$395,173	$346,461

Cost per Capacity Ton

The voyage cost of the vessel divided by the tons carried equals the cost per ton of shipping the cargo. With-project cost per capacity ton decreases with each incremental depth if the capacity of the vessel increases, because the voyage cost is fixed. Shown in **Table A-66** through **Table A-75** are the costs per capacity ton at each channel depth, along with the savings per ton transported for the with-project depths, for each of the vessel class's inbound and outbound journeys.

Table A-66: Susan Maersk (Post-Panamax) Cost per Short Ton and Savings per Short Ton by Channel Depth and Itinerary for Inbound Transit

Channel Depth	Total Capacity of Vessel - Far East Trade Region (Short Tons)	Total Capacity of Vessel - Europe Trade Region (Short Tons)	Total Capacity of Vessel - Mediterranean Trade Region (Short Tons)	Total Cost per Capacity Ton - Far East	Total Cost per Capacity Ton - Europe	Total Cost per Capacity Ton - Mediterranean
42	60,391	60,391	60,391	$28.08	$8.36	$10.36
43	64,234	64,234	64,234	$26.40	$7.86	$9.74
44	68,076	68,076	68,076	$24.91	$7.41	$9.19
45	71,919	71,919	71,919	$23.58	$7.02	$8.70
46	75,762	75,762	75,762	$22.38	$6.66	$8.26
47	79,604	79,604	79,604	$21.30	$6.34	$7.86
48	83,447	83,447	83,447	$20.32	$6.05	$7.50
49	87,290	87,290	87,290	$19.43	$5.78	$7.17
50	88,008	87,290	87,290	$19.27	$5.78	$7.17

Table A-67: Susan Maersk (Post-Panamax) Cost per Short Ton and Savings per Short Ton by Channel Depth and Itinerary for Outbound Transit

Channel Depth	Total Capacity of Vessel - Far East Trade Region (Short Tons)	Total Capacity of Vessel - Europe Trade Region (Short Tons)	Total Capacity of Vessel - Mediterranean Trade Region (Short Tons)	Total Cost per Capacity Ton - Far East	Total Cost per Capacity Ton - Europe	Total Cost per Capacity Ton - Mediterranean
42	60,391	60,391	60,391	$25.10	$7.72	$9.54
43	64,234	64,234	64,234	$23.60	$7.25	$8.97
44	68,076	68,076	68,076	$22.26	$6.84	$8.46
45	71,919	71,919	71,919	$21.08	$6.48	$8.01
46	75,762	75,762	75,762	$20.01	$6.15	$7.60
47	79,604	79,604	79,604	$19.04	$5.85	$7.24
48	83,447	83,447	83,447	$18.16	$5.58	$6.90
49	87,290	87,290	87,290	$17.36	$5.34	$6.60
50	87,290	88,008	88,008	$17.36	$5.29	$6.55

Table A-68: Regina Maersk (Post-Panamax) Cost per Short Ton and Savings per Short Ton by Channel Depth and Itinerary for Inbound Transit

Channel Depth	Total Capacity of Vessel - Far East Trade Region (Short Tons)	Total Capacity of Vessel - Europe Trade Region (Short Tons)	Total Capacity of Vessel - Mediterranean Trade Region (Short Tons)	Total Cost per Capacity Ton - Far East	Total Cost per Capacity Ton - Europe	Total Cost per Capacity Ton - Mediterranean
42	58,703	58,703	58,703	$24.28	$7.01	$8.69
43	61,789	61,789	61,789	$23.06	$6.66	$8.26
44	64,876	64,876	64,876	$21.97	$6.34	$7.86
45	67,962	67,962	67,962	$20.97	$6.05	$7.51
46	71,048	71,048	71,048	$20.06	$5.79	$7.18
47	74,135	74,135	74,135	$19.22	$5.55	$6.88
48	77,221	77,221	77,221	$18.45	$5.33	$6.61
49	79,999	79,999	79,999	$17.81	$5.14	$6.38
50	79,999	79,999	79,999	$17.81	$5.14	$6.38

Table A-69: Regina Maersk (Post-Panamax) Cost per Short Ton and Savings per Short Ton by Channel Depth and Itinerary for Outbound Transit

Channel Depth	Total Capacity of Vessel - Far East Trade Region (Short Tons)	Total Capacity of Vessel - Europe Trade Region (Short Tons)	Total Capacity of Vessel - Mediterranean Trade Region (Short Tons)	Total Cost per Capacity Ton - Far East	Total Cost per Capacity Ton - Europe	Total Cost per Capacity Ton - Mediterranean
42	58,703	58,703	58,703	$21.05	$6.47	$8.00
43	61,789	61,789	61,789	$20.00	$6.15	$7.60
44	64,876	64,876	64,876	$19.05	$5.86	$7.24
45	67,962	67,962	67,962	$18.18	$5.59	$6.91
46	71,048	71,048	71,048	$17.39	$5.35	$6.61
47	74,135	74,135	74,135	$16.67	$5.12	$6.34
48	77,221	77,221	77,221	$16.00	$4.92	$6.08
49	79,999	79,999	79,999	$15.45	$4.75	$5.87
50	79,999	79,999	79,999	$15.45	$4.75	$5.87

Table A-70: Composite Other Post-Panamax Cost per Short Ton and Savings per Short Ton by Channel Depth and Itinerary for Inbound Transit

Channel Depth	Total Capacity of Vessel - Far East Trade Region (Short Tons)	Total Capacity of Vessel - Europe Trade Region (Short Tons)	Total Capacity of Vessel - Mediterranean Trade Region (Short Tons)	Total Cost per Capacity Ton - Far East	Total Cost per Capacity Ton - Europe	Total Cost per Capacity Ton - Mediterranean
42	45,759	45,759	45,759	$25.99	$7.22	$8.95
43	48,204	48,204	48,204	$24.67	$6.85	$8.50
44	50,648	50,648	50,648	$23.48	$6.52	$8.09
45	53,092	53,092	53,092	$22.40	$6.22	$7.71
46	55,536	55,536	55,536	$21.41	$5.95	$7.38
47	57,980	57,980	57,980	$20.51	$5.70	$7.06
48	60,424	60,424	60,424	$19.68	$5.47	$6.78
49	62,869	62,869	62,869	$18.92	$5.25	$6.52
50	62,869	62,869	62,869	$18.92	$5.25	$6.52

Table A-71: Composite Other Post-Panamax Cost per Short Ton and Savings per Short Ton by Channel Depth and Itinerary for Outbound Transit

Channel Depth	Total Capacity of Vessel - Far East Trade Region (Short Tons)	Total Capacity of Vessel - Europe Trade Region (Short Tons)	Total Capacity of Vessel - Mediterranean Trade Region (Short Tons)	Total Cost per Capacity Ton - Far East	Total Cost per Capacity Ton - Europe	Total Cost per Capacity Ton - Mediterranean
42	45,759	45,759	45,759	$21.68	$6.67	$8.24
43	48,204	48,204	48,204	$20.58	$6.33	$7.82
44	50,648	50,648	50,648	$19.58	$6.02	$7.45
45	53,092	53,092	53,092	$18.68	$5.75	$7.10
46	55,536	55,536	55,536	$17.86	$5.49	$6.79
47	57,980	57,980	57,980	$17.11	$5.26	$6.50
48	60,424	60,424	60,424	$16.42	$5.05	$6.24
49	62,869	62,869	62,869	$15.78	$4.85	$6.00
50	62,869	62,869	62,869	$15.78	$4.85	$6.00

Table A-72: Madison Maersk (Panamax) Cost per Short Ton and Savings per Short Ton by Channel Depth for and Itinerary Inbound Transit

Channel Depth	Total Capacity of Vessel - Far East Trade Region (Short Tons)	Total Capacity of Vessel - Europe Trade Region (Short Tons)	Total Capacity of Vessel - Mediterranean Trade Region (Short Tons)	Total Cost per Capacity Ton - Far East	Total Cost per Capacity Ton - Europe	Total Cost per Capacity Ton - Mediterranean
42	39,159	46,027	46,027	$23.86	$7.52	$9.33
43	39,159	48,316	48,316	$23.86	$7.16	$8.88
44	39,159	50,606	50,606	$23.86	$6.84	$8.48
45	39,159	52,895	52,895	$23.86	$6.54	$8.12
46	39,159	53,781	53,781	$23.86	$6.44	$7.98
47	39,159	53,781	53,781	$23.86	$6.44	$7.98
48	39,159	53,781	53,781	$23.86	$6.44	$7.98
49	39,159	53,781	53,781	$23.86	$6.44	$7.98
50	39,159	53,781	53,781	$23.86	$6.44	$7.98

Table A-73: Madison Maersk (Panamax) Cost per Short Ton and Savings per Short Ton by Channel Depth and Itinerary for Outbound Transit

Channel Depth	Total Capacity of Vessel - Far East Trade Region (Short Tons)	Total Capacity of Vessel - Europe Trade Region (Short Tons)	Total Capacity of Vessel - Mediterranean Trade Region (Short Tons)	Total Cost per Capacity Ton - Far East	Total Cost per Capacity Ton - Europe	Total Cost per Capacity Ton - Mediterranean
42	46,027	46,027	46,027	$21.87	$6.94	$8.59
43	48,316	48,316	48,316	$20.83	$6.62	$8.18
44	50,606	50,606	50,606	$19.89	$6.32	$7.81
45	52,895	52,895	52,895	$19.03	$6.04	$7.47
46	53,781	53,781	53,781	$18.72	$5.94	$7.35
47	53,781	53,781	53,781	$18.72	$5.94	$7.35
48	53,781	53,781	53,781	$18.72	$5.94	$7.35
49	53,781	53,781	53,781	$18.72	$5.94	$7.35
50	53,781	53,781	53,781	$18.72	$5.94	$7.35

Table A-74: Zim Asia (Sub-Panamax) Cost per Short Ton and Savings per Short Ton by Channel Depth and Itinerary for Inbound Transit

Channel Depth	Total Capacity of Vessel - Far East Trade Region (Short Tons)	Total Capacity of Vessel - Europe Trade Region (Short Tons)	Total Capacity of Vessel - Mediterranean Trade Region (Short Tons)	Total Cost per Capacity Ton - Far East	Total Cost per Capacity Ton - Europe	Total Cost per Capacity Ton - Mediterranean
42	41,674	46,639	46,639	$19.88	$6.51	$8.07
43	41,674	46,639	46,639	$19.88	$6.51	$8.07
44	41,674	46,639	46,639	$19.88	$6.51	$8.07
45	41,674	46,639	46,639	$19.88	$6.51	$8.07
46	41,674	46,639	46,639	$19.88	$6.51	$8.07
47	41,674	46,639	46,639	$19.88	$6.51	$8.07
48	41,674	46,639	46,639	$19.88	$6.51	$8.07
49	41,674	46,639	46,639	$19.88	$6.51	$8.07
50	41,674	46,639	46,639	$19.88	$6.51	$8.07

Table A-75: Zim Asia (Sub-Panamax) Cost per Short Ton and Savings per Short Ton by Channel Depth and Itinerary for Outbound Transit

Channel Depth	Total Capacity of Vessel - Far East Trade Region (Short Tons)	Total Capacity of Vessel - Europe Trade Region (Short Tons)	Total Capacity of Vessel - Mediterranean Trade Region (Short Tons)	Total Cost per Capacity Ton - Far East	Total Cost per Capacity Ton - Europe	Total Cost per Capacity Ton - Mediterranean
42	46,639	46,639	46,639	$18.93	$6.01	$7.43
43	46,639	46,639	46,639	$18.93	$6.01	$7.43
44	46,639	46,639	46,639	$18.93	$6.01	$7.43
45	46,639	46,639	46,639	$18.93	$6.01	$7.43
46	46,639	46,639	46,639	$18.93	$6.01	$7.43
47	46,639	46,639	46,639	$18.93	$6.01	$7.43
48	46,639	46,639	46,639	$18.93	$6.01	$7.43
49	46,639	46,639	46,639	$18.93	$6.01	$7.43
50	46,639	46,639	46,639	$18.93	$6.01	$7.43

Tonnage

Table A-76 shows actual 2002 tonnage and predicted tonnage for the life of the project. **Table A-77** shows 2002 tonnage as a percentage of total tonnage by trade region and import or export tonnage.

Table A- 76: Actual and Predicted Tonnage at Miami Harbor by Trade Region

	Far East		
	Imports	**Exports**	**Total**
	Actual Tonnage	*Actual Tonnage*	*Actual Tonnage*
2002	746,862	335,540	1,082,402
Project Year Range	*Predicted Tonnage*	*Predicted Tonnage*	*Predicted Tonnage*
Years 1 - 5	1,043,083	436,817	1,479,900
Years 6 - 10	1,349,168	536,617	1,885,786
Years 11 - 15	1,945,931	718,115	2,664,046
Years 16 - 20	2,700,290	932,219	3,632,509
Years 21 - 25	3,619,777	1,176,935	4,796,712
Years 26 - 30	4,361,828	1,364,391	5,726,219
Years 31 - 35	5,255,999	1,581,703	6,837,702
Years 36 - 40	6,333,475	1,833,627	8,167,102
Years 41 - 45	7,631,833	2,125,676	9,757,509
Years 46 - 50	9,196,352	2,464,242	11,660,594
	Europe		
	Imports	**Exports**	**Total**
	Actual Tonnage	*Actual Tonnage*	*Actual Tonnage*
2002	1,549,637	394,669	1,944,306
Project Year Range	*Predicted Tonnage*	*Predicted Tonnage*	*Predicted Tonnage*
Years 1 - 5	2,164,254	484,842	2,649,096
Years 6 - 10	2,799,340	570,231	3,369,571
Years 11 - 15	4,037,542	716,753	4,754,295
Years 16 - 20	5,602,734	879,864	6,482,599
Years 21 - 25	7,510,544	1,056,515	8,567,059
Years 26 - 30	9,050,199	1,186,050	10,236,249
Years 31 - 35	10,905,483	1,331,466	12,236,949
Years 36 - 40	13,141,099	1,494,710	14,635,809
Years 41 - 45	15,835,014	1,677,970	17,512,983
Years 46 - 50	19,081,179	1,883,698	20,964,877
	Mediterranean		
	Imports	**Exports**	**Total**
	Actual Tonnage	*Actual Tonnage*	*Actual Tonnage*
2002	131,713	59,186	190,899
Project Year Range	*Predicted Tonnage*	*Predicted Tonnage*	*Predicted Tonnage*
Years 1 - 5	142,440	59,186	201,626
Years 6 - 10	151,727	59,186	210,913
Years 11 - 15	165,720	59,186	224,906
Years 16 - 20	179,393	59,186	238,579
Years 21 - 25	192,511	59,186	251,697
Years 26 - 30	201,232	59,186	260,418
Years 31 - 35	210,347	59,186	269,533
Years 36 - 40	219,876	59,186	279,062
Years 41 - 45	229,836	59,186	289,022
Years 46 - 50	240,248	59,186	299,434
	All Trade Routes		
	Imports	**Exports**	**Total**
	Actual Tonnage	*Actual Tonnage*	*Actual Tonnage*
2002	2,428,212	789,395	3,217,607
Project Year Range	*Predicted Tonnage*	*Predicted Tonnage*	*Predicted Tonnage*
Years 1 - 5	3,349,777	980,845	4,330,622
Years 6 - 10	4,300,236	1,166,034	5,466,270
Years 11 - 15	6,149,193	1,494,054	7,643,247
Years 16 - 20	8,482,418	1,871,270	10,353,687
Years 21 - 25	11,322,831	2,292,637	13,615,468
Years 26 - 30	13,613,259	2,609,627	16,222,886
Years 31 - 35	16,371,830	2,972,355	19,344,184
Years 36 - 40	19,694,450	3,387,524	23,081,973
Years 41 - 45	23,696,683	3,862,832	27,559,515
Years 46 - 50	28,517,779	4,407,125	32,924,904

Table A-77: Actual 2002 Tonnage by Trade Region

Trade Region	2002 Import Tonnage	Trade Region Share of Import Tonnage	2002 Export Tonnage	Trade Region Share of Export Tonnage	2002 Total Tonnage	Trade Region Share of Total Tonnage
Far East	746,862	31%	335,540	43%	1,082,402	34%
Europe	1,549,637	64%	394,669	50%	1,944,306	60%
Mediterranean	131,713	5%	59,186	7%	190,899	6%
Total	2,428,212	100%	789,395	100%	3,217,607	100%

Discounted Transportation Cost Savings (Benefits) at Each Depth

Table A-78 to **A-85** display the process of using the cost per ton savings calculated for the Susan Maersk's inbound transit for each channel depth for each trade route to find the total savings by year of the project at each potential depth. (A similar procedure is used to determine the savings per project year for the outbound transit and for the inbound and outbound transits of the other four vessel classes.) In **Table A-78** to **A-85,** expected tonnage is assigned to a vessel class and trade route utilizing the percentages found in **Tables A-66** to **A-75** and **Table A-77**.

Table A-78: Inbound Susan Maersk (Post-Panamax) Savings Resulting from 43 Foot Project by Trade Region and Project Year

Project Year	Susan Maersk (Post-Panamax) Tonnage per Year -Far East	Savings per Year Transporting Miami Harbor Tonnage - Far East	Susan Maersk (Post-Panamax) Tonnage per Year - Europe	Savings per Year Transporting Miami Harbor Tonnage - Europe	Susan Maersk (Post-Panamax) Tonnage per Year - Mediterranean	Savings per Year Transporting Miami Harbor Tonnage - Mediterranean	Total Savings per Year on Susan Maersk (Post-Panamax) Vessels
Years 1 - 5	6,356	$10,678	13,187	$6,592	1,121	$695	$17,964
Years 6 - 10	23,868	$40,098	49,523	$24,754	4,209	$2,609	$67,461
Years 11 - 15	59,635	$100,186	123,735	$61,850	10,517	$6,519	$168,555
Years 16 - 20	111,191	$186,799	230,706	$115,320	19,609	$12,155	$314,274
Years 21 - 25	184,670	$310,242	383,165	$191,528	32,568	$20,187	$521,957
Years 26 - 30	267,826	$449,943	555,703	$277,772	47,233	$29,277	$756,993
Years 31 - 35	369,848	$621,338	767,384	$383,583	65,225	$40,430	$1,045,351
Years 36 - 40	498,687	$837,787	1,034,709	$517,207	87,946	$54,514	$1,409,508
Years 41 - 45	663,979	$1,115,474	1,377,666	$688,636	117,096	$72,583	$1,876,693
Years 46 - 50	867,279	$1,457,015	1,799,487	$899,487	152,949	$94,807	$2,451,308

Table A-79: Inbound Susan Maersk (Post-Panamax) Savings Resulting from 44 Foot Project by Trade Region and Project Year

Project Year	Susan Maersk (Post-Panamax) Tonnage per Year -Far East	Savings per Year Transporting Miami Harbor Tonnage - Far East	Susan Maersk (Post-Panamax) Tonnage per Year - Europe	Savings per Year Transporting Miami Harbor Tonnage - Europe	Susan Maersk (Post-Panamax) Tonnage per Year - Mediterranean	Savings per Year Transporting Miami Harbor Tonnage - Mediterranean	Total Savings per Year on Susan Maersk (Post-Panamax) Vessels
Years 1 - 5	6,717	$21,294	13,936	$13,146	1,185	$1,386	$35,825
Years 6 - 10	25,085	$79,528	52,049	$49,097	4,424	$5,175	$133,800
Years 11 - 15	62,297	$197,501	129,258	$121,927	10,986	$12,851	$332,279
Years 16 - 20	115,585	$366,439	239,822	$226,221	20,384	$23,844	$616,503
Years 21 - 25	191,092	$605,822	396,491	$374,003	33,700	$39,420	$1,019,245
Years 26 - 30	275,814	$874,414	572,276	$539,819	48,641	$56,897	$1,471,130
Years 31 - 35	379,310	$1,202,531	787,018	$742,381	66,893	$78,248	$2,023,160
Years 36 - 40	509,488	$1,615,235	1,057,119	$997,164	89,851	$105,102	$2,717,500
Years 41 - 45	675,806	$2,142,512	1,402,205	$1,322,678	119,182	$139,411	$3,604,601
Years 46 - 50	879,799	$2,789,234	1,825,463	$1,721,930	155,157	$181,493	$4,692,657

Table A-80: Inbound Susan Maersk (Post-Panamax) Savings Resulting from 45 Foot Project by Trade Region and Project Year

Project Year	Susan Maersk (Post-Panamax) Tonnage per Year -Far East	Savings per Year Transporting Miami Harbor Tonnage - Far East	Susan Maersk (Post-Panamax) Tonnage per Year - Europe	Savings per Year Transporting Miami Harbor Tonnage - Europe	Susan Maersk (Post-Panamax) Tonnage per Year - Mediterranean	Savings per Year Transporting Miami Harbor Tonnage - Mediterranean	Total Savings per Year on Susan Maersk (Post-Panamax) Vessels
Years 1 - 5	7,075	$31,849	14,680	$19,662	1,248	$2,072	$53,583
Years 6 - 10	26,283	$118,308	54,533	$73,037	4,635	$7,698	$199,043
Years 11 - 15	64,884	$292,066	134,625	$180,307	11,443	$19,004	$491,377
Years 16 - 20	119,813	$539,324	248,596	$332,951	21,130	$35,093	$907,368
Years 21 - 25	197,218	$887,753	409,201	$548,053	34,780	$57,765	$1,493,571
Years 26 - 30	283,361	$1,275,516	587,936	$787,438	49,972	$82,997	$2,145,951
Years 31 - 35	388,181	$1,747,347	805,422	$1,078,723	68,458	$113,698	$2,939,768
Years 36 - 40	519,538	$2,338,636	1,077,971	$1,443,755	91,623	$152,173	$3,934,564
Years 41 - 45	686,731	$3,091,232	1,424,873	$1,908,369	121,109	$201,143	$5,200,744
Years 46 - 50	891,290	$4,012,031	1,849,306	$2,476,823	157,184	$261,059	$6,749,913

Table A-81: Inbound Susan Maersk (Post-Panamax) Savings Resulting from 46 Foot Project by Trade Region and Project Year

Project Year	Susan Maersk (Post-Panamax) Tonnage per Year -Far East	Savings per Year Transporting Miami Harbor Tonnage - Far East	Susan Maersk (Post-Panamax) Tonnage per Year - Europe	Savings per Year Transporting Miami Harbor Tonnage - Europe	Susan Maersk (Post-Panamax) Tonnage per Year - Mediterranean	Savings per Year Transporting Miami Harbor Tonnage - Mediterranean	Total Savings per Year on Susan Maersk (Post-Panamax) Vessels
Years 1 - 5	7,432	$42,343	15,420	$26,141	1,311	$2,755	$71,239
Years 6 - 10	27,460	$156,452	56,976	$96,586	4,843	$10,180	$263,218
Years 11 - 15	67,398	$383,996	139,842	$237,059	11,886	$24,986	$646,042
Years 16 - 20	123,886	$705,828	257,046	$435,742	21,848	$45,928	$1,187,498
Years 21 - 25	203,068	$1,156,960	421,338	$714,248	35,812	$75,282	$1,946,491
Years 26 - 30	290,505	$1,655,126	602,758	$1,021,790	51,232	$107,697	$2,784,614
Years 31 - 35	396,513	$2,259,098	822,710	$1,394,652	69,927	$146,997	$3,800,748
Years 36 - 40	528,913	$3,013,438	1,097,422	$1,860,342	93,277	$196,081	$5,069,861
Years 41 - 45	696,853	$3,970,263	1,445,875	$2,451,037	122,894	$258,341	$6,679,641
Years 46 - 50	901,875	$5,138,356	1,871,267	$3,172,158	159,050	$334,348	$8,644,863

Table A-82: Inbound Susan Maersk (Post-Panamax) Savings Resulting from 47 Foot Project by Trade Region and Project Year

Project Year	Susan Maersk (Post-Panamax) Tonnage per Year -Far East	Savings per Year Transporting Miami Harbor Tonnage - Far East	Susan Maersk (Post-Panamax) Tonnage per Year - Europe	Savings per Year Transporting Miami Harbor Tonnage - Europe	Susan Maersk (Post-Panamax) Tonnage per Year - Mediterranean	Savings per Year Transporting Miami Harbor Tonnage - Mediterranean	Total Savings per Year on Susan Maersk (Post-Panamax) Vessels
Years 1 - 5	7,787	$52,778	16,156	$32,582	1,373	$3,434	$88,795
Years 6 - 10	28,619	$193,977	59,380	$119,752	5,047	$12,622	$326,350
Years 11 - 15	69,844	$473,400	144,916	$292,253	12,317	$30,804	$796,456
Years 16 - 20	127,811	$866,298	265,189	$534,808	22,540	$56,369	$1,457,476
Years 21 - 25	208,659	$1,414,286	432,939	$873,108	36,798	$92,026	$2,379,421
Years 26 - 30	297,275	$2,014,928	616,806	$1,243,914	52,426	$131,109	$3,389,951
Years 31 - 35	404,354	$2,740,706	838,979	$1,691,972	71,310	$178,335	$4,611,013
Years 36 - 40	537,678	$3,644,377	1,115,609	$2,249,852	94,822	$237,136	$6,131,365
Years 41 - 45	706,258	$4,787,010	1,465,390	$2,955,255	124,552	$311,486	$8,053,751
Years 46 - 50	911,656	$6,179,193	1,891,562	$3,814,718	160,775	$402,074	$10,395,984

Table A-83: Inbound Susan Maersk (Post-Panamax) Savings Resulting from 48 Foot Project by Trade Region and Project Year

Project Year	Susan Maersk (Post-Panamax) Tonnage per Year -Far East	Savings per Year Transporting Miami Harbor Tonnage - Far East	Susan Maersk (Post-Panamax) Tonnage per Year - Europe	Savings per Year Transporting Miami Harbor Tonnage - Europe	Susan Maersk (Post-Panamax) Tonnage per Year - Mediterranean	Savings per Year Transporting Miami Harbor Tonnage - Mediterranean	Total Savings per Year on Susan Maersk (Post-Panamax) Vessels
Years 1 - 5	8,139	$63,153	16,888	$38,987	1,435	$4,109	$106,250
Years 6 - 10	29,759	$230,897	61,745	$142,544	5,248	$15,024	$388,466
Years 11 - 15	72,223	$560,380	149,853	$345,950	12,737	$36,463	$942,793
Years 16 - 20	131,596	$1,021,056	273,043	$630,348	23,208	$66,439	$1,717,844
Years 21 - 25	214,009	$1,660,500	444,039	$1,025,108	37,742	$108,047	$2,793,656
Years 26 - 30	303,702	$2,356,432	630,139	$1,454,741	53,559	$153,331	$3,964,504
Years 31 - 35	411,747	$3,194,757	854,318	$1,972,280	72,614	$207,880	$5,374,916
Years 36 - 40	545,892	$4,235,596	1,132,651	$2,614,841	96,271	$275,606	$7,126,043
Years 41 - 45	715,020	$5,547,868	1,483,569	$3,424,970	126,097	$360,994	$9,333,832
Years 46 - 50	920,722	$7,143,917	1,910,373	$4,410,289	162,374	$464,848	$12,019,055

Table A-84: Inbound Susan Maersk (Post-Panamax) Savings Resulting from 49 Foot Project by Trade Region and Project Year

Project Year	Susan Maersk (Post-Panamax) Tonnage per Year -Far East	Savings per Year Transporting Miami Harbor Tonnage - Far East	Susan Maersk (Post-Panamax) Tonnage per Year - Europe	Savings per Year Transporting Miami Harbor Tonnage - Europe	Susan Maersk (Post-Panamax) Tonnage per Year - Mediterranean	Savings per Year Transporting Miami Harbor Tonnage - Mediterranean	Total Savings per Year on Susan Maersk (Post-Panamax) Vessels
Years 1 - 5	8,491	$73,476	17,617	$45,360	1,497	$4,781	$123,617
Years 6 - 10	30,888	$267,298	64,089	$165,016	5,447	$17,393	$449,707
Years 11 - 15	74,571	$645,318	154,725	$398,386	13,151	$41,990	$1,085,694
Years 16 - 20	135,326	$1,171,077	280,784	$722,963	23,866	$76,201	$1,970,240
Years 21 - 25	219,285	$1,897,628	454,986	$1,171,498	38,672	$123,477	$3,192,603
Years 26 - 30	310,062	$2,683,191	643,337	$1,656,465	54,681	$174,593	$4,514,248
Years 31 - 35	419,112	$3,626,872	869,600	$2,239,046	73,913	$235,997	$6,101,915
Years 36 - 40	554,161	$4,795,551	1,149,809	$2,960,528	97,729	$312,042	$8,068,121
Years 41 - 45	723,991	$6,265,207	1,502,182	$3,867,819	127,680	$407,671	$10,540,697
Years 46 - 50	930,229	$8,049,934	1,930,098	$4,969,618	164,051	$523,801	$13,543,354

Table A-85: Inbound Susan Maersk (Post-Panamax) Savings Resulting from 50 Foot Project by Trade Region and Project Year

Project Year	Susan Maersk (Post-Panamax) Tonnage per Year -Far East	Savings per Year Transporting Miami Harbor Tonnage - Far East	Susan Maersk (Post-Panamax) Tonnage per Year - Europe	Savings per Year Transporting Miami Harbor Tonnage - Europe	Susan Maersk (Post-Panamax) Tonnage per Year - Mediterranean	Savings per Year Transporting Miami Harbor Tonnage - Mediterranean	Total Savings per Year on Susan Maersk (Post-Panamax) Vessels
Years 1 - 5	8,491	$73,476	17,617	$45,360	1,497	$4,781	$123,617
Years 6 - 10	30,888	$267,298	64,089	$165,016	5,447	$17,393	$449,707
Years 11 - 15	74,571	$645,318	154,725	$398,386	13,151	$41,990	$1,085,694
Years 16 - 20	135,326	$1,171,077	280,784	$722,963	23,866	$76,201	$1,970,240
Years 21 - 25	219,285	$1,897,628	454,986	$1,171,498	38,672	$123,477	$3,192,603
Years 26 - 30	310,062	$2,683,191	643,337	$1,656,465	54,681	$174,593	$4,514,248
Years 31 - 35	419,112	$3,626,872	869,600	$2,239,046	73,913	$235,997	$6,101,915
Years 36 - 40	554,161	$4,795,551	1,149,809	$2,960,528	97,729	$312,042	$8,068,121
Years 41 - 45	723,991	$6,265,207	1,502,182	$3,867,819	127,680	$407,671	$10,540,697
Years 46 - 50	930,229	$8,049,934	1,930,098	$4,969,618	164,051	$523,801	$13,543,354

Yearly transportation savings by depth for the five vessel classes are summed together and discounted to the base year of the project using the current federal rate of 5.625 percent, and the total of the discounted yearly transportation savings at a given depth represents the total base year benefit of the project at that depth. **Table A-86** presents the total discounted transportation savings for each potential channel depth.

Using the Federal discount rate of 5.625 percent and the fifty-year life of the project to annualize the benefits produces the Average Annual Equivalent (AAEQ) benefits of the project at each depth. **Table A-86** displays total AAEQ benefits for each potential channel depth.

Table A-86: Total Discounted and Average Annual Equivalent Benefits for Each Potential Project Depth at Miami Harbor

Channel Depth	Transportation Benefits	AAEQ Transportation Benefits
Deepen System to 43 Feet	$40,788,344	$2,453,354
Deepen System to 44 Feet	$78,205,117	$4,703,914
Deepen System to 45 Feet	$112,673,088	$6,777,108
Deepen System to 46 Feet	$139,055,626	$8,363,976
Deepen System to 47 Feet	$160,522,169	$9,655,154
Deepen System to 48 Feet	$180,868,182	$10,878,934
Deepen System to 49 Feet	$199,628,174	$12,007,318
Deepen System to 50 Feet	$200,133,356	$12,037,704

Benefits During Construction (BDC)

There will be no benefits during construction associated with the Miami Harbor project because all widening improvements must be in place to accrue vessel delay elimination benefits, and deepening of the harbor will occur simultaneously with widening improvements.

Advance Utility Replacement Benefits

Replacement of two utility lines will be necessary for any deepening alternative. The cost of these utility replacements is charged as a project cost. The benefit of the extended useful life of each utility line is added to the project benefits. See the Main Report for more information about the replacement of the utility lines and the calculation of the advanced utility replacement benefits.

Total Benefits

Total benefits include channel improvement benefits and benefits associated with advance utility replacement. Total AAEQ project benefits are shown in **Table A-87**.

Table A-87: Total AAEQ Benefits

Project	AAEQ Improvement Benefits	AAEQ Advance Utility Replacement Benefits	Total Benefits
1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel	$2,848,000		$2,848,000
1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin	$4,140,000		$4,140,000
Deepen System to 43 Feet	$6,593,354	$84,268	$6,677,622
Deepen System to 44 Feet	$8,843,914	$84,268	$8,928,182
Deepen System to 45 Feet	$10,917,108	$84,268	$11,001,376
Deepen System to 46 Feet	$12,503,976	$84,268	$12,588,243
Deepen System to 47 Feet	$13,795,154	$84,268	$13,879,422
Deepen System to 48 Feet	$15,018,934	$84,268	$15,103,202
Deepen System to 49 Feet	$16,147,318	$84,268	$16,231,586
Deepen System to 50 Feet	$16,177,704	$84,268	$16,261,972

COSTS

CONSTRUCTION COSTS

Construction costs for each project are summarized in **Table A-88**. See the Main Report and Appendix B for a complete discussion of the costs shown in **Table A-88**.

INTEREST DURING CONSTRUCTION

Interest During Construction (IDC) is calculated to account for the opportunity cost of expended funds before the benefits of the project are available. Using the project schedule for each increment (see Main Report), projected expenditures are plotted on a construction timeline and the opportunity costs of those expenditures are calculated using the current Federal discount rate of 5.625 percent.

Adding the IDC to the construction cost for each project produces the real cost of the project at the point in time that the project is completed. See **Table A-88** for IDC costs for each alternative project.

FISHER ISLAND BULKHEAD REPLACEMENT COST

Damage to the Fisher Island Bulkhead, as described in the Main Report, is treated as an economic cost of the project. The appropriate cost figure is the difference between the without-project cost of repairing the bulkheads, thereby deferring replacement, and the higher with-project cost of immediately replacing them. Future maintenance costs are also included in the computations. The costs are calculated based on the present value of the expected fifty-year cash flows associated with each condition.

The Port of Miami's Fisher Island Bulkhead Assessment Report (September 5, 2003), prepared by Shaw Environmental & Infrastructure, Inc., evaluates the condition of the bulkheads and provides a financial cost analysis for repairs and maintenance. Repair and replacement costs with remaining useful life estimates are in Table 1 of the report. Maintenance costs are also provided.

The report states that "Segment A is in poor condition and requires immediate repair or replacement. Segment B is in fair condition and needs immediate repair or replacement within 5 years. Segment C is in good condition and needs only minor maintenance." The remaining useful life after repairs is given as one to two years for Segment A, three to five years for Segment B, and greater than 15 years for Segment C. Based on these figures, the without-project cost of the bulkheads was calculated assuming Segment A has a useful life after repairs of only one year due to its "poor" condition and Segment B has a useful life of five years due to its "fair" condition.

For Segment A the cost of repairing and then replacing the bulkhead (i.e., the without project condition) is $989,275. The cost of replacing the bulkhead upfront (i.e., the with project condition) is $1,036,522. This results in a cost of $47,247 for Segment A. For

Segment B the cost of repairing and then replacing the bulkhead is $792,373 and the cost of replacing the bulkhead upfront is $1,036,522, resulting in a cost of $244,149 for Segment B. Segment C only has repair costs. Ferry Slip does not have any costs.

Total cost for Fisher Island Bulkhead replacement is $291,395, as shown in **Table A-88**; total AAEQ cost is $17,527, as shown in **Table A-89**.

Table A-88: Construction Cost and Economic Costs

Project	Construction Cost	IDC	Fisher Island Bulkhead Replacement Cost	Total Cost
1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel	$22,599,315	$1,306,100	$291,395	$24,196,810
1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin	$26,229,817	$1,626,130	$291,395	$28,147,342
Deepen System to 43 Feet	$92,381,593	$8,976,522	$291,395	$101,649,510
Deepen System to 44 Feet	$104,480,828	$10,899,345	$291,395	$115,671,568
Deepen System to 45 Feet	$111,995,359	$12,078,924	$291,395	$124,365,678
Deepen System to 46 Feet	$118,831,812	$12,873,054	$291,395	$131,996,261
Deepen System to 47 Feet	$127,362,809	$14,337,505	$291,395	$141,991,710
Deepen System to 48 Feet	$137,487,666	$15,924,445	$291,395	$153,703,506
Deepen System to 49 Feet	$149,033,579	$19,262,453	$291,395	$168,587,427
Deepen System to 50 Feet	$157,506,768	$21,568,088	$291,395	$179,366,251

AVERAGE ANNUAL EQUIVALENT (AAEQ) COSTS

Just as project benefits are converted to AAEQ benefits, project costs are converted to AAEQ costs using the Federal discount rate of 5.625 percent to annualize the costs over the 50-year life of the project.

Table A-89 displays AAEQ construction cost, AAEQ IDC, and total AAEQ costs for each project.

Table A-89: Miami Harbor AAEQ Costs

Project	AAEQ Construction Cost	AAEQ IDC	AAEQ Fisher Island Bulkhead Replacement Cost	AAEQ Total Cost
1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel	$1,359,313	$78,560	$17,527	$1,455,400
1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher	$1,577,682	$97,809	$17,527	$1,693,018
Deepen System to 43 Feet	$5,556,606	$539,924	$17,527	$6,114,057
Deepen System to 44 Feet	$6,284,356	$655,578	$17,527	$6,957,462
Deepen System to 45 Feet	$6,736,343	$726,528	$17,527	$7,480,398
Deepen System to 46 Feet	$7,147,545	$774,294	$17,527	$7,939,366
Deepen System to 47 Feet	$7,660,671	$862,378	$17,527	$8,540,576
Deepen System to 48 Feet	$8,269,665	$957,830	$17,527	$9,245,022
Deepen System to 49 Feet	$8,964,134	$1,158,606	$17,527	$10,140,267
Deepen System to 50 Feet	$9,473,782	$1,297,286	$17,527	$10,788,596

NATIONAL ECONOMIC DEVELOPMENT PLAN ANALYSIS

The National Economic Development (NED) plan is determined by analyzing the increments of the project in order to evaluate alternative plans. Components of the project—individual construction features that improve the channel—are discussed in detail in the Main Report. Project increments are either individual components that generate benefits independently or inseparable groups of components that generate benefits interdependently. Alternative Plans are different combinations of project increments.

Three categories of potential transportation cost reduction benefits are attainable through improvements to the Port:

- The first benefit category is a reduction in the number of tug assists needed for Post-Panamax container vessels, as well as a reduction in the transit time for Post-Panamax container vessels, resulting from widening the channel (interdependent components 1C, 2A, and 5A).
- The second benefit category is a decrease in the time spent by vessels while navigating the channel because of the availability of an additional turning basin, resulting from extending the Fisher Island Turning Basin (independent component 3B).
- The third benefit category is a reduction in, or an elimination of, light loading, resulting from deepening the channel (independent component Deepening to Optimal NED depth).

Eight Alternative Plans can be formed from the three benefit categories:

- Alternative Plan A: No Action Plan
- Alternative Plan B: Widen the Channel (Components 1C, 2A, and 5A)
- Alternative Plan C: Extend the Fisher Island Turning Basin (Component 3B)
- Alternative Plan D: Widen the Channel (Components 1C, 2A, and 5A) and Extend the Fisher Island Turning Basin (Component 3B)
- Alternative Plan E: Deepen the Previously-Authorized Channel Configuration
- Alternative Plan F: Widen the Channel (Components 1C, 2A, and 5A) and Deepen the Resulting Channel Configuration
- Alternative Plan G: Extend the Fisher Island Turning Basin (Component 3B) and Deepen the Resulting Channel Configuration
- Alternative Plan H: Widen the Channel (Components 1C, 2A, and 5A), Extend the Fisher Island Turning Basin (Component 3B), and Deepen the Resulting Channel Configuration

An additional Alternative Plan, Alternative Plan I, comprises the extension of the Dodge Island Channel and the construction of the Dodge Island Turning Basin. These components were found to be unfeasible following a preliminary benefit/cost analysis and were not included in the final set of Alternative Plans.

Utilized to select the plan from the Alternative Plans A-H that provides the highest net NED benefits, the NED Plan Analysis process compares costs to NED benefits for each increment of the project. In order to be included in the NED plan, each increment must be justified (provide benefits that exceed costs) based on a comparison of its marginal costs and benefits. By including only those increments that have positive net benefits, the NED Plan maximizes the net benefits of the project. **Table A-90** provides AAEQ costs and benefits, and net benefits for each project increment, revealing those increments that have positive net benefits.

Table A-90: Costs and Benefits of Project Increments

Increment	Incremental AAEQ Cost	Incremental AAEQ Benefits	Net Incremental AAEQ Benefits
1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel	$1,455,400	$2,848,000	$1,392,600
3B Extend Fisher Island Turning Basin	$237,618	$1,292,000	$1,054,382
Deepen System from 42 Feet to 43 Feet	$4,421,039	$2,537,622	-$1,883,417
Deepen System from 43 Feet to 44 Feet	$843,405	$2,250,560	$1,407,155
Deepen System from 44 Feet to 45 Feet	$522,937	$2,073,194	$1,550,257
Deepen System from 45 Feet to 46 Feet	$458,967	$1,586,868	$1,127,900
Deepen System from 46 Feet to 47 Feet	$601,210	$1,291,179	$689,968
Deepen System from 47 Feet to 48 Feet	$704,446	$1,223,780	$519,334
Deepen System from 48 Feet to 49 Feet	$895,244	$1,128,384	$233,140
Deepen System from 49 Feet to 50 Feet	$648,329	$30,386	-$617,943

The first increment examined is channel widening. A comparison of the benefits and cost of Components 1C, 2A, and 5A shows that the benefits exceed the cost, so this increment has a positive net benefit and is part of the NED plan. This finding eliminates four of the alternative plans, leaving Alternative Plans B, D, F, and H.

The second increment examined is extending the Fisher Island Turning Basin. A comparison of the additional benefits and cost of the project resulting from adding Component 3B shows that the marginal benefits exceed the marginal cost, so this increment has a positive net benefit and is part of the NED plan. This finding eliminates two of the remaining alternative plans, leaving Alternative Plans D and H.

The final set of increments examined is deepening the newly configured channel from its current depth of 42 feet to depths up to 50 feet. A comparison of the benefits and costs of the potential deepening projects shows that one foot of deepening (to 43 feet in the inner channel and 45 feet in the outer channel) has a negative net benefit; however, further deepening produces positive net benefits that are maximized at 49/51 feet of project depth. Therefore, 49 feet is the NED depth for the deepening project, and deepening the channel to 49 feet is part of the NED plan, eliminating Alternative Plan D and leaving Alternative Plan H as the NED Plan.

Table A-91 confirms that NED net benefits are maximized with Alternative Plan H, which includes widening the channel, extending the Fisher Island Turning Basin, and deepening the resulting channel system to 49/51 feet. The benefit/cost ratio of the NED Plan is 1.60.

Table A-91: Costs and Benefits of Alternative Plans

Alternative Plan	AAEQ Total Costs	AAEQ Benefits	Net AAEQ Benefits	Benefit/Cost Ratio
Alternative Plan A: No Action	$0	$0	$0	n/a
Alternative Plan B: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel	$1,455,400	$2,848,000	$1,392,600	1.96
Alternative Plan C: 3B Extend Fisher Island Turning Basin	$237,618	$1,292,000	$1,054,382	5.44
Alternative Plan D: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin	$1,693,018	$4,140,000	$2,446,982	2.45
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 43 Feet	$6,114,057	$6,677,622	$563,565	1.09
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 44 Feet	$6,957,462	$8,928,182	$1,970,720	1.28
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 45 Feet	$7,480,398	$11,001,376	$3,520,977	1.47
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 46 Feet	$7,939,366	$12,588,243	$4,648,878	1.59
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 47 Feet	$8,540,576	$13,879,422	$5,338,846	1.63
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 48 Feet	$9,245,022	$15,103,202	$5,858,180	1.63
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 49 Feet	$10,140,267	$16,231,586	$6,091,320	1.60
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 50 Feet	$10,788,596	$16,261,972	$5,473,376	1.51

MULTIPORT ANALYSIS

GENERAL

The purpose of the multiport analysis is to assess whether or not improvements at Miami Harbor would result in a diversion of cargo traffic from competing ports to Miami Harbor. Diverted traffic from competing U.S. ports is not a National Economic Benefit (NED) as there is no increase in the net value of the national output of goods and services. If it is determined that there is an impact, the forecasted cargo traffic at Miami Harbor would be adjusted by an amount derived from the analysis cargo movements and transportation costs at competing ports.

Miami Harbor is the southernmost major port on the Atlantic coast. Its location referenced to other major South Atlantic Region ports is as follows: 21 nautical miles south of Port Everglades, Florida; 83 nautical miles south of Palm Beach, Florida; 173 nautical miles south of Port Canaveral, Florida; 306 nautical miles south of Jacksonville, the most northern port on Florida's Atlantic Coast; 386 nautical miles south of Savannah, Georgia; and 420 nautical miles south of Charleston, South Carolina. These ports, as well as, Tampa, Florida, could be a competing port for one or more of the commodities handled by Miami Harbor.

As shown in **Table A-5**, about 97 percent of all cargo handled by the Port of Miami is containerized cargo transported in containers or trailers. The remaining 3 percent is neobulk and breakbulk cargo. Thus, only containerized cargo movements at competing ports needs to be considered.

For containerized cargo, this analysis will (1) identify containerized cargo volumes at competing ports; (2) assess the extent of the overlap in the flow of containerized cargo in the hinterlands served by each of the potential competing ports, and (3) identify any advantages/disadvantages in (a) transportation costs, and (b) institutional and/or cargo capacity constraints resulting from port administration, terminal operators, and/or stevedore companies' policies, and/or future growth; and then, if appropriate, (4) quantify any diverted containerized cargo traffic due to improvements at Miami Harbor.

Ports also compete for cruise ship business. For Miami Harbor, the competition includes Port Canaveral, the Port of Tampa, and Port Everglades Florida. Each of these ports has sufficient channel depth to accommodate the largest cruise ships. Cruise ships with overall lengths of 800 feet or more have design drafts of 24 to 30 feet. Only two older large cruise ships, the NORWAY (1961) and QUEEN ELIZABETH 2 (1969), have design drafts in excess of 30 feet, 34.4 feet and 32.6 feet, respectively. The QUEEN MARY 2, which is scheduled for completion in 2003, will have a design draft of 32.8 feet. The design cruise ship for the study, the VOYAGER OF THE SEAS, has a design draft of 28.2 feet. Thus, deepening the Main Channel at Miami Harbor from its current 36 feet would not divert any cruise ship business to Miami Harbor. Accordingly, deepening the Main Channel was not considered.

Cruise ship operators stated that they are concerned mostly with sufficient berthing area to accommodate several large cruise ships at the same time. The Port proposed that additional berthing space be developed for smaller cruise ships at Terminal 12 at the southeastern end of Dodge Island. This would provide additional berthing space for the larger cruise ships at the main cruise terminals at the northwestern end of Dodge Island. However, a preliminary analysis determined that benefits were insufficient to justify the construction of this alternative (Alternative 6). Even without the development of this new facility, there does not appear to be any reason for a transfer of cruise ship business from Miami Harbor due to the adequacy of berthing space, as competing ports face the same berthing constraints.

CONTAINERIZED CARGO

Import and export (non-domestic) liner tonnage is shown in **Table A-92** for Miami Harbor, Port Everglades, Palm Beach Harbor, Port Canaveral, Jacksonville Harbor, and Tampa Harbor. In 1999, Miami Harbor had the most containerized cargo tonnage (4,399,517 short tons), approximately 1.7 times that of Port Everglades (2,599,447 short tons), which had the second highest volume of containerized cargo. Jacksonville had the third highest volume (1,457,143 short tons), about 56 percent of Port Everglades' total and 33 percent of Miami Harbor's total. It should be noted that the total for Jacksonville Harbor does not include containerized cargo trade with Puerto Rico, which represents a significant portion of it's overall containerized cargo trade, as it is classified as domestic tonnage (cargo moving between U.S. ports). Palm Beach Harbor, Tampa Harbor, and Port Canaveral have significantly less containerized cargo trade than Miami Harbor: 421,098; 199,886; and 44,225 short tons, respectively.

Tampa Harbor serves a different hinterland than Miami Harbor, as does Jacksonville Harbor. Palm Beach Harbor overlaps the northern portion of Miami Harbor's hinterland. However, it is not anticipated that improvements at Miami Harbor would shift a significant portion of containerized cargo from Palm Beach Harbor to Miami Harbor, or for that matter, Port Everglades, as the cargo delivered to Palm Beach Harbor supplies the local market. Port Canaveral's containerized cargo is also consumed locally, and by the Port's cruise ship business (Disney cruise ship homeport).

The ports of Savannah, Georgia, and Charleston, South Carolina, are respectively 386 and 420 nautical miles north of the Port of Miami. Due to the significant landside trucking costs associated with transshipping cargo between the Port of Miami and either the Port of Savannah or the Port of Charleston, potential cargo shifts among them were not considered economical viable.

Miami Harbor and Port Everglades are only 21 nautical miles from each other. Thus, their hinterlands overlap. If any shifting of containerized cargo did occur due to improvements at Miami Harbor, it would most likely be from Port Everglades.

Table A-93 displays recorded entries from Piers Import Export Reporting Service (PIERS) for select containerized cargo types (vegetable products, food products, and manufactured products) for Miami Harbor and Port Everglades in 1999. As shown in **Table A-93**, the two ports strongly compete in the Central American market as demonstrated by similar total of recorded entries: Miami Harbor, 140; Port Everglades, 154, based on the sample countries: Costa Rica, Guatemala, Nicaragua, and Panama. In this trade, container ships are generally small due to constraints at Central American ports (shallow depths and lack of gantry cranes). But, small Panamax class (maximum beam 106 feet) containerships are employed in this trade region. These small Panamax class container ships have design drafts between 38 and 41 feet. But, they normally do not fully load. So, their actual transit drafts are typically less than their design drafts. Currently, both Miami Harbor and Port Everglades have 42-foot channel depths. Thus, deepening Miami Harbor beyond 42 feet would not impact these vessels; and accordingly, would not bring about a shift in cargo traffic from Port Everglades to Miami Harbor.

The most significant difference in the level of containerized cargo traffic between Miami Harbor and Port Everglades is in the European and Asian trade regions. As shown in **Table A-93**, Miami had 244 total records in the sample of European countries (France, Italy, Spain, and the United Kingdom), while Port Everglades had only 119. Similarly, in the sample of Asian countries (Mainland China, Hong Kong, and Japan), Miami had 124 records, while Port Everglades had 23. If Port Everglades remains at 42 feet, while Miami Harbor is deepened beyond 42 feet, it is possible that some containerized cargo could shift from Port Everglades to Miami Harbor. Landside costs are comparable between the two ports, and the shipping distances between these ports and those in various trade regions are, for all practical purposes, the same. Moreover, most containerized cargo is trucked from the ports. Therefore, land transportation costs are approximately the same and would not change. With a deeper channel, container ships can transport more cargo, reducing the shipping cost per ton. If Miami Harbor were two to three feet deeper than Port Everglades for an extended period of time, the reduction in at sea transportation costs could induce some cargo to shift from Port Everglades to Miami Harbor. However, it is very doubtful that any significant difference in channel depth would continue for a long enough period to induce any shift. The rational economic ("most likely") action for both port authorities would be to insure, at a minimum, channel depth parity. Currently, both ports are 42 feet deep.

Throughput constraints are very critical with respect to potential inducements to shift cargo movements to another port. As cargo traffic grows in the future, both Miami Harbor and Port Everglades will have to make capital expenditures in storage facilities, cargo handling equipment, and intermodal facilities to insure that cargo can be efficiently handled. Accordingly, general indicators of capacity constraints will be used herein to assess the potential for a shift in cargo movements. The intent is to assess the their overall capacities, not the capacities of individual terminals within them.

In fiscal year 2000, Miami Harbor recorded 868,178 TEUs, while Port Everglades recorded 676,760 TEUs. Miami Harbor currently has 363 acres (274 onsite and 89 offsite), while Port Everglades has 302 acres of dedicated container storage. Thus, Miami had a productivity rate (throughput per acre) of 2,392 TEUs per acre, while Port Everglades had a productivity rate of 2,241 TEUs per acre. Both ports are projected to have an overall average annual growth rate of between 4 and 5 percent over the 50-year study period; that is, 2010 to 2060. The single-payment-compound-growth factor for a 60-year period (current year, 2000, to end of study period, 2060) at an annual growth rate of 4.5 percent (midpoint of 4 and 5 percent) is 14.027408. Multiplying each port's number of TEUs in fiscal year

2000 by 14.027408 results in 12,178,287 TEUs for Miami Harbor and 9,493,189 TEUs for Port Everglades. So, by 2060, the ports would have to be able to respectively handle 12.2 and 9.5 million TEUs, assuming a uniform average weight per container.

Cargo throughput capacity consists of a series of connected components: gantry cranes, wharf, terminal equipment, temporary storage facilities, and intermodal connections. The level of cargo that can be handled by these components will depend on key factors: gantry crane and cargo storage handling equipment capacity utilization, container dwell time, storage density, and general operating characteristics (hours per day and days per week day).

With respect to equipment capacity utilization, the big factor is hours of operation. To illustrate, gantry cranes are utilized to their maximum operational capacity at Asian ports, operating on a daily schedule of 20 hours of operations and 4 hours of maintenance, 365 days a year: Twenty hours per day x 40 container moves (minimum) per hour x 1.7 (ratio of total containers to TEUs) x 365 days = 496,400 TEUs per year. So, by year 50 of the study period (2060), Miami would need 25 (12,178,287 TEUs/496,400 TEUs), while Port Everglades would need 20 cranes (9,493,189 TEUs/496,400 TEUs). Currently, Miami Harbor has 12 (2 of the 12 will arrive in 2003/4); it will have to add 13 over the 60-year period. Port Everglades Harbor has 7 gantry cranes; it would also have to add 13. Thus, both ports would have to add approximately two to three (2.6) gantry cranes every 10 years and appropriate cargo-storage handling equipment, if they implemented a "24/7" operation, with equipment operating 20 hours per day. Most of the terminals at the ports do not operate on a "24/7" schedule. Both ports advised that there are no institutional restrictions to a "24/7" operation. The terminal operators set the daily hours of operation (yard hours). The hours of operation reflect the level of container traffic. As container traffic increases over time, it is reasonable to expect that the terminal operators would expand their operational hours, since this would be "economically rational" behavior. Moreover, increasing the number of container moves per hour would reduce the number of required gantry cranes. For example, doubling the number on container moves from 40 to 80 would eliminate the need for additional gantry cranes. Thus, this illustration demonstrates that amount of equipment and the extent of its utilization does not present a capacity constraint at either port.

Because of limited availability and cost, land for the temporary storage of containers (loaded and empty) has the potential to constrain future growth. Currently, Miami Harbor as 363 acres, while Port Everglades Harbor has 302 acres of dedicated container storage. Based on information from a cargo handling equipment manufacturer, 480 loaded containers can be stored on one acre (6 rows of containers wide, 4 containers high, and 20 rows deep) with either a reach-stacker or Rubber Tire Gantry (RTG). If a top-loader is used, 320 loaded containers can be stored on one acre. Empty containers can be stacked higher, up to eight containers high. Stacking eight containers high results in an additional 480 containers per acre. Empty containers represent 25 to 30 percent of both ports' total annual TEUs. In the future, the ports will most likely stack empties higher as an easy way to increase temporary container shortage capacity. But, for this general assessment to determine if throughput constraints over time would result in containerized cargo shifts among competing ports, this assumption does not affect the results. Moreover, trailers are stored at about 50 40-footers per acre, or 100 TEUs per acre. Since trailers are not stacked, one acre can accommodate 100 loaded or empty TEUs. Trailers represent about 40 percent at Miami Harbor and about 10 percent of total annual TEUs at Port Everglades. Trailers will be replaced with containers, as storage space becomes a constraint. This transition has begun at Miami Harbor. Seaboard Marine is already replacing RO/RO vessels with "Combos," that is, vessels that carry both trailers and containers.

Both ports provided information on container dwell time. The weighted average for loaded and empty containers for both ports is about 9 days. Containers on one acre would turn over 40.5 times (365 days in a year/9 days). So, one acre has an annual container storage capacity of 19,440 TEUs (480 TEUs x 40.5) with RTGs or reach-stacker, and 12,960 TEUs (320 TEUs x 40.5) with a top-loader.

Presently, Miami Harbor currently uses a combination of RTGs and toploaders. Assuming a utilization of 30 percent RTGs and 70 % toploaders, Miami Harbor has an annual container storage capacity of 5,410,152 TEUs (363 acres x 14,904 TEUs per acre). Port Everglades uses only toploaders. Therefore, Port Everglades Harbor currently has an annual container storage capacity of 3,913,920 TEUs (302 acres x 12,960 TEUs per acre). The year in which each ports container storage capacity would be exceeded for various annual growth rates is displayed in **Table A-94**. For illustrative purposes, the projected average annual growth rate for both ports is assumed to be 4.5 percent, as previously discussed. At this rate of annual growth, the projected annual container throughput at Miami Harbor would exceed the port's overall container storage capacity in year 42 from the current year (2000) and in year 32 from the base year of the study period (2010); for Port Everglades Harbor, years 40 and 30 respectively, assuming no change in container storage acreage, in the composition ("mix") of cargo handling equipment, and in general landside container handling over time. Any improvements in these operational factors would increase the number of years of estimated storage capacity. But, given the stated assumptions, both ports would reach their temporary container storage capacity to handle future growth at about the same time in the distant future with their current dedicated container storage acreage.

Based on discussions with port staff, both ports have additional land that could be used for container storage, but the amount is limited; as is available acreage at or adjacent to the existing port facilities. In the future, the most likely course of action would be to purchase or lease off-site acreage for the storage of empty containers, which can be stored at twice the density of loaded containers. Furthermore, as containerized cargo tonnage increases over time, it is reasonable to expect that the average container weight will increase. Therefore, fewer containers will be transporting more cargo in the future. The values shown in **Table A-94** assume no change in the uniform average container weight over the 60-year period. Thus, containers grow at the same annual rate as cargo. With heavier, but fewer containers, both ports would reach their container storage capacities later than the years shown in **Table A-94**.

The terminals at ports are as efficient as the circumstances require. The Port of Miami efficiently moves the current number of containers and trailers. However, as the amount of containerized cargo grows, operational and infrastructure changes will need to occur. The

Port of Miami plans for these changed conditions through their Port Master Development Plan and associated capital improvement program (POM 2020 Master Implementation Plan). Recently, larger, faster gantry cranes have been installed and more are on order. Rubber-Tire Gantry (RTG) cranes have replaced traditional stackers. These cranes allow for higher stacking of containers, freeing up more Port-side yard space. Additional Port-side yard space is being made available by the transition from trailers to "grounded" containers, and the utilization of off-site storage facilities for empty containers. On-island transportation improvements, particularly separation of cruise and cargo traffic and construction of cargo gates, is also expected to improve the efficiency of cargo movement. Moreover, the Port is committed to promoting rail delivery of regional waterborne cargo through on-Port rail improvements and the development off-site intermodal container transfer facilities. Furthermore, the Florida Department of Transportation (DOT)'s planned multi-lane tunnel from Dodge Island to Watson Island will facilitate Port traffic, reducing congestion in the immediate Port area. These improvements, which are part of the Port Master Development Plan, will significantly reduce truck traffic to and from the Port on local (particularly Downtown Miami), regional and state roads. On-island capital improvements are paid for by tariffs, terminal leases, and state and federal grants. Given the Port's landside capital improvement record and planned improvements via the Master Plan, it is reasonable to assume that any future growth in cargo and vessel calls would be handled by capital and operational improvements financed by the Port and paid for by tariffs and terminal leases, as well as grant and loan programs. Off-island improvements are funded through local, state and federal programs. Accordingly, it is assumed that necessary capital and operational improvements will be implemented in a planned manner as needed over time and paid for without the project.

Berthing capacity is not anticipated to be a problem for benefiting cargo vessels at Miami Harbor. To illustrate, Table A-1 shows that Bays 99 to 140 (Gantry Crane Berths) have a total of 5,500 liner feet of continuous berthing space. Base on discussions with the Biscayne Bay Pilots Association, the pilots allow about 66 feet (20 meters) between vessels at the berth. They refer to this practice as "shoehorn" or "steel-to-steel" berthing, which is common worldwide. This practice would continue with the Post-Panamax container ships. Taking into account this distance between vessels, four S-Class (SUSAN MAERSK, LOA 1,138 feet) container ships can be berth at a time. A maximum of five Post-Panamax container ships can be accommodated depending on the combination of sizes: S-Class SUSAN MAERSK, LOA 1,138 feet; K-Class REGINA MAERSK, LOA 1,044 feet; and a Composite-Class, LOA 909 feet (see Table A-33). Currently, the large container ships are at the dock between 12 and 15 hours, or an average of 13.5 hours. So, dividing the total hours in a year, 8,760, by 13.5 hours results in 649, which is the maximum annual number of vessels per individual berthing space. Multiplying this value by the total number of vessels that can be accommodated at a single time results in the total annual number of vessels that can be berthed at Bays 99 to 140: 649 x 4 = 2,596 and 649 x 5 = 3,244 vessels. As shown in Table A-45, 1,842 Post-Panamax and 553 Panamax calls, or a total of 2,395 calls are forecasted for years 46 to 50 of the planning period. With the annual capacity to handle between 2,600 and 3,200 Post-Panamax ship calls, this berthing area will be able to accommodate forecasted ship calls benefiting from deepening the channel, minimizing any potential harbor congestion.

Most local capital improvements and related land acquisitions are budgeted for two time periods: short-term, 1 to 5 years; and long-term, 6 to 10 years. Local master plans usually cover a 20-year time horizon, and very often include recommended capital improvements and land acquisitions that are intended to implement the objectives of the master plan. Future cargo facility plans and associated capital expenditures were reviewed for each port, and found to be commensurate with projected growth in containerized cargo growth within their normal planning and budgeting time frames. For example, both ports are investing in additional land storage areas, intermodal facilities, and upgraded gantry cranes for the next generation of Post-Panamax container ships. Thus, the ports have demonstrated that they have historically provided and would provide in the future the funds to purchase land and equipment, as well as extend their hours of operation, as required to accommodate growth in containerized cargo traffic.

Thus, the general indicators of port capacity to handle future growth show that there is no compelling evidence that improvements at either port would result in a shift in cargo movements from one port to the other due to throughput capacity constraints.

The projected future containerized cargo tonnage is based, primarily, on historical annual growth at Miami Harbor with no planned change in current trade region vessel itineraries. The annual growth in Asian and European trade regions is assumed to apply uniformly to all competing ports. As such, no shifting of cargo is expected to result from this growth.

SUMMARY

Based on a review of factors that would indicate whether the improvements at Miami Harbor could potentially result in a shift in containerized cargo from competing ports to Miami Harbor, it is concluded that no significant amount of cargo tonnage would shift.

Table A-92: Liner Imports and Exports for Port Everglades, Miami Harbor, Palm Beach Harbor, Port Canaveral, Jacksonville Harbor, Tampa Harbor 1999 (Short Tons)

Port	Total	Imports	% Of Total	Exports	% Of Total
Port Everglades	2,599,447	1,264,240	48.63%	1,335,207	51.37%
Miami	4,399,517	2,554,021	58.05%	1,845,495	41.95%
Palm Beach	421,098	94,756	22.50%	326,341	77.50%
Canaveral	44,225	39,753	89.89%	4,472	10.11%
Jacksonville	1,457,143	793,121	54.43%	664,022	45.57%
Tampa	199,886	88,555	44.30%	111,331	55.70%

Source: U.S. Imports and Exports, U.S. Customs, Maritime Administration, National Date Center of the U.S. Army Corps of Engineers Web Site.

Table A-93: Foreign Cargo Imports and Exports Recorded Entries for Sample of Containerized Cargo Types: Vegetable Products, Food Products, and Manufactured Products - 1999

	Port Everglades		Miami Harbor		Port Everglades		Miami Harbor		Port Everglades		Miami
	#66 Vegetable Products	#66 Vegetable Products	#66 Vegetable Products	#66 Vegetable Products	#68 Food Products	#68 Food Products	#68 Food Products	#68 Food Products	#70 Manufactured Products	#70 Manufactured Products	#70 Manufactured Products
	Import	Export	Import	Export	Import	Export	Import	Export	Import	Export	Import
Central America											
Costa Rica	6	5	1	4	6	8	6	6	10	11	5
Guatemala	5	5	4	4	7	7	4	6	8	7	6
Nicaragua	3	1	0	3	4	3	3	5	5	4	2
Panama	6	8	7	8	6	8	11	9	8	13	12
Total	20	19	12	19	23	26	24	26	31	35	25
Europe											
France	1	1	4	1	3	4	8	6	7	5	11
Italy	5	0	14	2	4	4	16	9	9	9	21
Spain	4	2	12	3	7	5	11	9	8	8	17
United Kingdom	2	1	4	4	4	3	13	7	15	8	24
Total	12	4	34	10	18	16	48	31	39	30	73
Asia											
China	0	0	6	0	0	0	7	3	10	1	29
Hong Kong	0	0	2	1	0	0	2	2	3	0	3
Japan	0	0	5	3	0	1	6	10	6	2	26
Total	0	0	13	4	0	1	15	15	19	3	58

	Port Everglades		Miami Harbor		
	Total Import Records	Total Export Records	Total Import Records	Total Export Records	Total Records
Central America	74	80	61	79	140
Europe	69	50	155	89	244
Asia	19	4	86	38	124

Source: Port Import Export Reporting Service (PIERS) from Corps of Engineers Navigation Data Center Web Site

Table A-94: Year Number of Projected TEUs Exceeds Current Container Storage (Acres) At Various Annual Growth Rates

	Port Everglades Harbor	Miami Harbor
FY 2000 TEUs	676,760	868,178
Current Container Storage (Acres) [1]	302	363
Current TEU Capacity (TEUs) [2]	3,913,920	5,410,152
Current Year 2000 = Year 0 Base Year of Study 2010 = Year 10 (Study period 2010 – 2060)	Year Throughput > Capacity From Current Year /Study Base Year	Year Throughput > Capacity From Current Year/Study Base Year
Annual Rate = 4.0%	Year 45/35	Year 47/37
Annual Rate = 4.5%	Year 40/30	Year 42/32
Annual Rate = 5.0%	Year 36/26	Year 38/28

[1] Source: Port Authority. Acres dedicated to temporary container storage.
[2] Number of current container storage acres x capacity of one acre per year:
Port Everglades Harbor: 12,960 TEUs (320 TEUs per acre x 40.5 turnover factor).
Miami Harbor: 14,904 TEUs (368 TEUs per acre x 40.5 turnover factor).

RISK AND UNCERTAINTY

SENSITIVITY ANALYSES

Risk and uncertainty associated with the economic analysis are addressed through sensitivity analyses that modify the values associated with key assumptions and/or input parameters to determine the impact of the change on estimated benefits and costs, as well as project formulation. For this study, cargo growth rates and interest rates were identified for sensitivity tests.

INCREASE OR DECREASE IN FEDERAL DISCOUNT RATE

The current Federal interest rate is 5 5/8 percent. By policy, the Federal interest rate cannot change more than one-quarter of a percent per year; therefore, to account for a potential annual adjustment in the interest rate, interest rates of 5 3/8 percent and 5 7/8 percent were used. The impacts on benefits and costs resulting from these changes are shown in **Table A-95 and Table A-96**. These tables show that with an increase or a decrease in the Federal Discount rate, the NED plan for Miami Harbor would remain Alternative H deepened to 49 feet.

Table A-95: Sensitivity: NED Analysis with Increase in Federal Discount Rate

Costs, Benefits, Net Benefits, and Benefit/Cost Ratio for Alternative Plans

Alternative Plan	AAEQ Total Costs	AAEQ Benefits	Net AAEQ Benefits	Benefit/Cost Ratio
Alternative Plan A: No Action	$0	$0	$0	n/a
Alternative Plan B: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel	$1,513,685	$2,848,000	$1,334,315	1.88
Alternative Plan C: 3B Extend Fisher Island Turning Basin	$247,579	$1,292,000	$1,044,421	5.22
Alternative Plan D: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin	$1,761,264	$4,140,000	$2,378,736	2.35
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 43 Feet	$6,365,099	$6,600,660	$235,561	1.04
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 44 Feet	$7,244,959	$8,786,425	$1,541,466	1.21
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 45 Feet	$7,790,486	$10,800,441	$3,009,956	1.39
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 46 Feet	$8,268,540	$12,337,148	$4,068,607	1.49
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 47 Feet	$8,896,090	$13,584,195	$4,688,104	1.53
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 48 Feet	$9,630,974	$14,766,735	$5,135,761	1.53
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 49 Feet	$10,569,160	$15,857,601	$5,288,440	1.50
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 50 Feet	$11,248,280	$15,887,075	$4,638,795	1.41

Table A-96: Sensitivity: NED Analysis with Decrease in Federal Discount Rate

Costs, Benefits, Net Benefits, and Benefit/Cost Ratio for Alternative Plans

Alternative Plan	AAEQ Total Costs	AAEQ Benefits	Net AAEQ Benefits	Benefit/Cost Ratio
Alternative Plan A: No Action	$0	$0	$0	n/a
Alternative Plan B: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel	$1,401,951	$2,848,000	$1,446,049	2.03
Alternative Plan C: 3B Extend Fisher Island Turning Basin	$228,536	$1,292,000	$1,063,464	5.65
Alternative Plan D: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin	$1,630,487	$4,140,000	$2,509,513	2.54
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 43 Feet	$5,872,269	$6,745,992	$873,723	1.15
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 44 Feet	$6,680,015	$9,063,709	$2,383,694	1.36
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 45 Feet	$7,180,854	$11,198,225	$4,017,370	1.56
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 46 Feet	$7,621,096	$12,837,114	$5,216,018	1.68
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 47 Feet	$8,196,564	$14,174,082	$5,977,518	1.73
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 48 Feet	$8,871,229	$15,440,637	$6,569,408	1.74
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 49 Feet	$9,724,753	$16,607,922	$6,883,169	1.71
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 50 Feet	$10,343,146	$16,639,250	$6,296,104	1.61

ZERO GROWTH

To determine if future cargo growth is required for project justification, a sensitivity analysis was conducted assuming zero growth from the base year, 2010, to the end of the project life, 2060. The results of this assessment are displayed in **Table A-97**. This assessment shows that growth in cargo traffic is required for benefits to exceed costs. Zero growth is not a realistic assumption; however, it is an expeditious way to demonstrate whether or not a project is economically justified without growth.

Table A-97: Sensitivity: Costs and Benefits of Project Increments with Zero Growth

Costs, Benefits, Net Benefits, and Benefit/Cost Ratio for Alternative Plans

Alternative Plan	AAEQ Total Costs	AAEQ Benefits	Net AAEQ Benefits	Benefit/Cost Ratio
Alternative Plan A: No Action	$0	$0	$0	n/a
Alternative Plan B: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel	$1,457,397	$2,848,000	$1,390,603	1.95
Alternative Plan C: 3B Extend Fisher Island Turning Basin	$237,976	$1,292,000	$1,054,024	5.43
Alternative Plan D: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin	$1,695,372	$4,140,000	$2,444,628	2.44
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 43 Feet	$6,116,498	$4,769,994	-$1,346,504	0.78
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 44 Feet	$6,959,919	$5,278,047	-$1,681,873	0.76
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 45 Feet	$7,482,864	$5,748,211	-$1,734,653	0.77
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 46 Feet	$7,941,833	$6,079,440	-$1,862,393	0.77
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 47 Feet	$8,543,052	$6,328,980	-$2,214,072	0.74
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 48 Feet	$9,247,506	$6,568,110	-$2,679,396	0.71
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 49 Feet	$10,142,780	$6,790,886	-$3,351,893	0.67
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 50 Feet	$10,791,125	$6,797,335	-$3,993,790	0.63

GROWTH CONSISTENT WITH RECENT HISTORICAL GROWTH

A more realistic test of growth assumptions is to assess the impact of modifying an assumption that represents a deviation from the historical average annual rate of growth and that could have a major impact on project benefits. Specifically, in the analysis, future growth rates for European and Far East import cargo were assumed to be less than their historical average annual rates from 1990 to 2000, 7.6 percent compared to 8.14 and 11.66 percent, respectively. The results of assuming the higher rates of growth at least for the near-term, from 2003 to the base year, 2010, are shown in **Table A-98**. As shown in these tables, the NED plan for Miami Harbor remains Alternative H to 49 feet.

Table A-98: Sensitivity: Costs and Benefits of Project Increments with High Growth

Costs, Benefits, Net Benefits, and Benefit/Cost Ratio for Alternative Plans

Alternative Plan	AAEQ Total Costs	AAEQ Benefits	Net AAEQ Benefits	Benefit/Cost Ratio
Alternative Plan A: No Action	$0	$0	$0	n/a
Alternative Plan B: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel	$1,457,397	$2,848,000	$1,390,603	1.95
Alternative Plan C: 3B Extend Fisher Island Turning Basin	$237,976	$1,292,000	$1,054,024	5.43
Alternative Plan D: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin	$1,695,372	$4,140,000	$2,444,628	2.44
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 43 Feet	$6,116,498	$10,328,304	$4,211,805	1.69
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 44 Feet	$6,959,919	$15,919,288	$8,959,369	2.29
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 45 Feet	$7,482,864	$21,057,378	$13,574,513	2.81
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 46 Feet	$7,941,833	$25,102,884	$17,161,051	3.16
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 47 Feet	$8,543,052	$28,471,142	$19,928,090	3.33
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 48 Feet	$9,247,506	$31,649,507	$22,402,001	3.42
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 49 Feet	$10,142,780	$34,567,965	$24,425,185	3.41
Alternative Plan H: 1C Widen Entrance Channel, 2A Widener between Buoys 13 and 15, 5A Widen Fishermans Channel and 3B Extend Fisher Island Turning Basin, and Deepen Channel to 50 Feet	$10,791,125	$34,644,184	$23,853,058	3.21