SOCIO-ECONOMIC STATISTICS

Population projections of the Bureau of Economic Analysis regional area for the years 1995 - 2020 are given in table 1. Population projections are as reported in the Florida Statistical Abstract by the Bureau of Economic and Business Research, College of Business Administration, University of Florida (1994). Population in 1990 is from the April 1990 Census.

TABLE 1

POPULATION PROJECTIONS
TAMPA-ST. PETERSBURG REGIONAL AREA

COUNTY	1990	1995	2000	2005	2010	2015	2020
Charlotte	110,975	130,400	153,600	176,200	198,600	221,300	243,800
Citrus	93,513	106,800	123,100	138,800	154,400	170,100	185,700
Collier	152,099	187,600	222,200	256,000	289,500	323,400	357,100
De Soto	23,865	26,300	28,500	30,700	32,800	34,900	36,900
Hardee	19,499	22,300	23,100	23,800	24,500	25,200	25,800
Hernando	101,115	120,600	144,500	168,000	191,300	215,100	238,700
Highlands	68,432	78,500	85,400	94,000	102,400	110,900	119,200
Hillsborough	834,054	892,300	962,300	1,028,800	1,093,100	1,156,800	1,218,600
Lee	335,113	376,600	428,100	478,000	527,200	576,700	625,600
Manatee	211,707	232,700	257,400	281,100	304,300	327,500	350,200
Pasco	281,131	306,400	340,100	372,400	403,900	435,500	466,400
Pinellas	851,659	879,800	919,500	958,100	996,200	1,033,800	1,070,300
Polk	405,382	443,900	481,200	517,000	551,800	586,500	620,400
Sarasota	277,776	301,200	329,800	357,000	383,500	409,800	435,400
TOTAL	3,766,320	4,103,400	4,498,800	4,879,900	5,253,500	5,627,500	5,994,100

COMMODITIES

Commodity tonnage that moved over the Big Bend Channel in the past 20 years has experienced accelerated growth. During the first full year of operation in 1970, the channel had 302,000 tons of cargo as shown in table 2. The total tonnage in 1990 was 10,500,000 tons. Table 2 shows the development of tonnage by the various commodities from 1970 to 1994 on that channel. Appendix B provides more discussion and information concerning the commodity movements.

Phosphate Rock. Tug/barge units move the majority of phosphate rock from Big Bend to Donaldsonville or Uncle Sam, Louisiana. When Freeport/McMoran purchased Agrico Inc. in 1988, the operation became larger with the movement of Freeport/McMoran's operation from the East area in Tampa to Big Bend. The Big Bend terminal then went from loading on a standard 5 day week to a 7 day week, 24 hours a day. Table 2 shows the tonnage change and breakdown by commodity.

Coal. As electric demand increased and more generating capacity was added to the plant at Big Bend, table 2 shows an overall growth in coal movements. Nearly all of the coal arrives from Davant, Louisiana by tug/barge units. Since 1970, only one shipment by self-propelled bulk carriers moved coal from another source to the terminal at Big Bend.

Phosphate Chemical. Self-propelled bulk carriers normally transport Granular Triple Super Phosphate (GTSP) and Di-ammonium Phosphate (DAP) from Big Bend to destinations throughout the world. GTSP amounts generally show an overall growth with yearly fluctuations. Chemical tankers transport phosphoric acid to destinations in South and Central America, the Caribbean, and U.S. ports. Integrated tug/barge units transport phosphate chemicals mainly to Donaldsonville which is just upstream from Davant, Louisiana.

TABLE 2

COMMODITY HISTORY
(1,000 SHORT TONS)

YEARS	COAL	PHOSPHATE ROCK	GTSP	PHOSPHORIC ACID	MISC.	TOTAL
1970	301.7	0	0	0	0	**301.7**
1971	658.0	0	0	0	0	**658.0**
1972	1,216.1	0	0	0	0	**1,216.1**
1973	1,540.6	0	0	0	0	**1,540.6**
1974	1,826.7	0	0	0	4.8	**1,831.5**
1975	1,707.2	436.4	0	2.2	0	**2,145.8**
1976	2,216.6	1,295.5	122.6	89.7	0	**3,724.4**
1977	2,385.8	2,417.3	215.9	121.6	12.8	**5,153.4**
1978	2,551.5	2,725.0	352.4	156.2	23.1	**5,808.2**
1979	2,439.1	2,917.5	280.7	181.3	21.9	**5,840.5**
1980	2,429.5	2,847.0	320.3	177.1	10.2	**5,784.1**
1981	3,241.9	2,426.1	344.5	193.8	0	**6,206.3**
1982	2,870.9	2,115.6	244.6	212.7	0	**5,443.8**
1983	3,239.0	2,380.8	449.6	193.3	0	**6,262.7**
1984	3,196.0	2,755.4	381.3	309.4	0	**6,642.1**
1985	4,167.9	3,005.4	576.8	361.9	4.9	**8,116.9**
1986	3,390.2	2,704.9	441.1	269.8	25.0	**6,831.0**
1987	4,431.5	2,640.6	623.2	236.9	17.7	**7,949.9**
1988	4,507.2	3,732.6	514.8	313.9	18.5	**9,087.0**
1989	4,178.3	5,628.4	472.8	321.4	24.3	**10,625.2**
1990	4,160.9	5,683.4	490.2	218.8	44.0	**10,597.3**
1991	4,053.1	5,743.2	517.2	81.8	9.0	**10,404.3**
1992	4,442.7	5,537.5	562.7	164.8	0	**10,707.7**
1993	4,659.6	4,336.8	559.7	255.2	0	**9,811.3**

SOURCE: Tampa Port Authority

TAMPA HARBOR HISTORIC DREDGED VOLUMES

The Tampa Port Authority has a draft maintenance dredging disposal plan (1994) for Tampa Harbor. That plan was a source of historic data and potential projections for future maintenance dredging associated with the study area. Development data in appendix F, the dredged material management plan, came primarily from that document. An analysis of past construction and maintenance work provides a setting for future dredging and disposal efforts.

The Port Authority's maintenance disposal plan indicates material removed from the main ship channel in the study area amounted to about 32,500,000 cubic yards (CY) between 1978 to 1994. That plan used the year 1978 as a reference point based on availability and accuracy of data from that year. Since construction of disposal islands 2D and 3D around 1980, about 8,000,000 CY of maintenance and 1,000,000 CY of construction material have gone into the islands from dredging.

ALAFIA RIVER AND BIG BEND CHANNEL DISPOSAL SITES

Historically, disposal of dredged material from the Alafia River and Big Bend navigation projects involved only about five upland locations on the mainland. No dredged material went into disposal islands 2D or 3D which are primarily for the Tampa Harbor main ship channel. Only two of those upland locations had a significant amount of remaining capacity prior to 1994 and both are in private ownership. One is near Alafia River and is for maintenance of that project. The other is in the vicinity of Big Bend.

A 67-acre disposal site, located north of Alafia River, is in private ownership. It had about 600,000 CY of capacity prior to 1994. That site is exclusively for the disposal of dredged material from the Alafia River Channel and Turning Basin. Maintenance and deepening of the authorized ship channel on Alafia River in 1994-1995 resulted in the filling of that area to capacity.

The disposal area under private ownership at Big Bend has an estimated capacity of about 650,000 CY in 1996. That site is exclusively for disposal of dredged material from the private ship channels, basin, and berthing areas in the vicinity of Big Bend.

DISPOSAL ISLANDS 2D AND 3D CAPACITIES

The creation of disposal islands 2D and 3D was part of the Federal deepening of the Tampa Harbor navigation project in 1978 to 1982. Since construction, about 6,021,000 CY of dredged material has gone into 2D and 1,896,000 CY into 3D. Surveys in 1990 indicated the remaining capacities in 2D and 3D were about 4,018,000 and 3,614,000 CY, respectively. The dike elevation at the time of the survey was about 20 feet above mean low water and has remained at that height during this study. Placement of dredged material from 1990 to 1994 involved maintenance work on ship channels and berths and amounted to about 2,252,000 CY into 3D and 893,000 CY into 2D. Remaining capacities at the beginning of 1994 were about 1,362,000 CY in 3D and 3,125,000 CY in 2D.

BIG BEND MAINTENANCE AND DISPOSAL AREA

The estimated average shoaling rate on the existing navigation channel at Big Bend is about 60,000 CY a year. Completion of the most recent maintenance to remove shoals occurred in 1994. The after dredging survey is in appendix A. That survey information on depths was the basis for estimating quantities to improve depths and widths on the existing project. That maintenance work involved a required depth of 34 feet with an allowable overdepth of 2 feet. The dredged material from that maintenance went into a private upland site. Available information from the area indicates a private upland disposal area existed in 1995 with an estimated 650,000 CY of remaining capacity for disposal of dredged material.

VESSEL FLEET

The existing fleet of vessels currently using the Big Bend navigation project consists of integrated tug/barge units, self propelled bulk carriers, and self propelled chemical tankers. The vast majority of cargo movement is via barge to and from destinations on the Mississippi River. The integrated tug/barge units range in size from about 700 to 800 feet with beams of 85 feet and drafts up to 36 feet. Typical barges in the fleet are in table B-3 of appendix B. The bulk carriers range up to 740 feet in length and 106 feet in beam with maximum drafts of 41 feet. Drafts and beams of the tankers are comparable to the bulk carriers, with slightly shorter lengths. More information on the self-propelled ships in appendix B, tables B-26, B-30, B-58, and B-76.

FUTURE CONDITIONS
WITHOUT NAVIGATION IMPROVEMENTS

The focus of the analysis on future conditions was mainly on the cargo movements at the Big Bend facilities and maintenance of the channels and berths serving the terminals. The cargo movements involve tonnage and vessels. Appendix B provides the projections of tonnage and vessel fleets to handle the movement of cargo. Appendix F provides a dredged material management plan for disposal of material in the upper Tampa Bay area involving the use of disposal islands 2D and 3D.

PORT CARGO TONNAGE

The prospective tonnages involve coal, phosphate ore, and phosphate products. The phosphate products are granulated triple super-phosphate (GTSP) and phosphoric acid. Steady increases in tonnage for coal, phosphate ore, and GTSP are likely into the future. The U.S. Department of Interior's Bureau of Mines provided information for the projection of phosphate related commodities. Appendix B provides a more detailed discussion which further explains the commodity projections.

Coal. Projected shipments relate to population which has risen steadily. Movements in 1990 were about 4.16 million tons[2] and 4.66 million tons in 1993. The estimate of projected tonnage in appendix B, table B-2, shows a leveling off in 2007 at about 5.96 million tons for the foreseeable future.

Phosphate Ore. Shipments of phosphate ore dominates the tonnage movement now from the phosphate terminal. Estimates for the near future are in appendix B, table B-29. Shipments of about 5.5 million tons in 1994 are likely to have only a slight annual growth to about 7.4 million tons in the year 2017. The forecast beyond that year is a gradual decline in tonnage to zero by the year 2029.

Phosphoric Acid. Shipments of phosphoric acid started in 1975. The product is a chemical liquid. As shown in tables 2 and B-75 in appendix B, records of past shipments show a very irregular annual tonnage over the years. The overall tonnage from 1977 to 1993 averages about 221,800 tons. No increase in that overall average annual tonnage is foreseeable in the near future for that product.

2 Tonnage measurements in this report are in short tons unless otherwise stated.

Granulated Triple Super Phosphate (GTSP). Tables 2 and B-45 in appendix B show GTSP tonnage beginning about 1976. Annual amounts have been somewhat irregular but overall have generally shown an increase through the years. Current estimates are for a gradual growth from about 530,000 tons in 1994 to about 713,000 tons in the year 2017. The fore-cast beyond that year is for a gradual decline in tonnage to zero by the year 2029.

FUTURE VESSEL FLEET MOVEMENTS

Projections for the vessel fleets are in appendix B and involve the use of bulk vessels to move cargo. Those vessels include deep draft barges and ships. Table references from that appendix provide the vessels sizes and tonnage distributions associated with the prospective fleet.

Coal Vessels. Barges are likely to handle most of the coal. Tables B-2 in appendix B shows the distribution between deep draft barge and self-propelled bulk carriers. Table B-3 shows the size barge which range from about 17,500 to 39,700 deadweight tons (DWT metric). Tables B-5 through B-11 show the barge tonnage relationship without improvement at a depth of 34 feet. The remaining coal movement is on self-propelled ships. Tables B-26 through B-28 show the without improvement depth of 34 feet for that portion of the movement.

Phosphate Vessels. Ore shipments in table B-29 move mainly on barges of about 23,100 to 39,700 DWT metric. Table B-30 provides the barge fleet characteristics. Tables B-31 through B-37 in appendix B show the distribution of tonnage for the without improvement depth of 34 feet. Granulated triple super-phosphate (GTSP) projections in table B-45 move by both deep draft barges and ships. Barge movements are in tables B-47 through B-53. Self-propelled carriers are in tables B-58 through B-74. The total shipment of GTSP is about equally distributed between barge and ship. Most of the phosphoric acid movements are on self-propelled bulk carriers of 10,000 to 20,000 DWT. Table B-75 shows the distribution between foreign and domestic. Tables B-76 through B-83 have the without improvement analysis at a depth of 34 feet.

TERMINAL FACILITIES

Current operations are likely to continue without improvements to existing navigation conditions. Loading and unloading facilities are in good condition and with proper maintenance are likely to remain that way for the near future without significant modification. The only change that could occur is with the Port Redwing property to the north of the phosphate rock and chemical loading facilities.

The Tampa Port Authority recently acquired about 150 acres, adjacent to the east channel in Port Redwing, for development. The port authority is promoting the area as a prime maritime/industrial site. The potential for future development exists with or without improvement.

BIG BEND DISPOSAL AREA

The existing navigation channel at Big Bend has an estimated shoaling rate of about 60,000 CY a year. Without any improvements proposed in this report, that shoal material is likely to continue at about the same average rate. Disposal will likely continue into the private upland site. That existing site would enable dredging and disposal operations for about 10 years of maintenance. At the end of that period, private interests in the area would have to review available options such as seeking other upland sites, reuse existing disposal sites, or negotiate with the Tampa Port Authority to use disposal island 3D.

DISPOSAL ISLANDS 2D AND 3D

The Tampa Port Authority needs to raise the dikes in disposal islands 2D and 3D for future maintenance of the Tampa Harbor navigation project. Both disposal islands have dikes now at an elevation of about 20 feet above mean low water. At that elevation, the remaining capacity in 1994 for 2D and 3D is about 3,125,000 CY and 1,362,000 CY, respectively. Based on subsurface conditions, the maximum dike elevation on disposal island 3D is 40 feet above mean low water (mlw). The area within disposal island 2D has two cells separated with a dike. The northern portion has the potential for a dike height of 40 feet above mlw. The southern portion has the potential for a dike height of only 25 feet above mlw.

Disposal Island 3D. Material for a maximum dike elevation does not exist on disposal island 3D. To add another 20 feet to the dike height requires about 3.34 million CY of suitable construction material. To make repairs to the existing dike requires about 35,000 CY. Only 1.7 million CY of material exists on the island for dike construction. The remaining material needs to come from another source. Maintenance in the near future is likely to provide a small amount of the required material.

Increasing the dike height with material from inside disposal island 3D adds capacity. Using the existing good material within the area to raise the dike and do repairs could help add capacity for future use. A 20-foot increase in dike height adds about 8,600,000 CY without considering the material used from inside the dikes (1.7 million CY) or existing capacity within the area (1.36 million CY). The estimated combined capacity using the existing capacity with the amounts from potential dike increases and removal of inside material is about 11.7 million CY.

Excluding the shoal material from the navigation channels at Alafia River and Big Bend, the average annual maintenance material for placement in disposal island 3D is an estimated 280,000 CY a year from other project channel work. The average shoal removal from Alafia River is about 130,000 CY a year. Assuming half that amount goes into disposal island 3D in the future, the total maintenance amount going into that island increases to 345,000 CY a year. If the 60,000 CY a year of shoaling from the existing Big Bend private project goes into the island, the total amount increases to an estimated 405,000 CY a year.

Disposal Island 2D. Construction grade material for higher dikes on disposal island 2D does exist on the island. A maximum dike elevation in the northern and southern portion would enable an estimated increase in capacity of about 10 million CY. Adding that increase to the existing capacity of 3.125 million CY in 1994 gives a total of about 13.1 million CY.

Shoal material for placement in 2D accumulates at an average rate of about 371,000 CY a year, excluding the Alafia River shoal material. Using that rate decreases the existing capacity to 157,000 CY a year by the end of 1998. Higher dikes increase the capacity by about 10,000,000 CY. The addition of about 65,000 CY in shoal material a year from the Alafia River maintenance in the year 2000 increases the shoaling rate to 436,000 CY a year. The life expectancy from the year 2000 is about 22 years for disposal island 2D.

OTHER DREDGED MATERIAL USES

Maximizing the potential for disposal of maintenance material from a Federal project is an important objective for continued channel usage. Several opportunities are available for use of material in a manner beneficial to the environment. A number of deep holes exists in Tampa Bay. Filling of those holes would improve the environment in them. Using material to expand islands for bird nesting is beneficial. Consideration of material for those uses benefits the environment and reduces the need for space within a disposal area. A beneficial uses plan with dredged material can be studied under a separate authority.

PROBLEM IDENTIFICATION

The major problem to shippers, using the existing Big Bend navigation features, is the lack of navigable channel depths and widths for safe and economic transport of their commodities. The existing channel does not allow optimum use of the current vessel fleet. The use of shallow to moderate draft vessels occurs at a higher unit cost for transport. Deeper depths for more draft and tonnage reduces the unit cost for transport and enables a greater vessel selection from larger vessels in the world fleet. The problem becomes even more prominent as the trend toward larger and deeper draft vessels continues in the world fleet.

NAVIGATION PROBLEMS

Discussions with the pilots indicate that navigation on the Big Bend channel is difficult in non-ideal conditions. Ideal conditions are characterized by slack tide in daylight hours with no wind. Under such conditions, the pilots take precautionary measures to handle vessel maneuverability. Navigation is more difficult when pilots must move a vessel under non-ideal conditions.

Wind. The predominant external force in Hillsborough Bay is the wind. The pilots will not transit the channel with an integrated tug/barge when winds are greater than 18 knots. Winds and cross currents acting on those vessels will cause it to crab or skew in the channel (see figure 6). A vessel that moves at a slight angle to the centerline of the channel uses more channel width. A vessel length of 750 feet requires an angle less than 10 degrees in the existing bottom width of 200 feet. An angle equal to or greater than that between the centerline of the channel and the ship in the center of the channel would be sufficient to put that vessel beyond the channel boundaries. Crabbing in the Big Bend Channel is a common occurrence due to the frequent high winds on Hillsborough and Tampa Bays.

Speed. Under the current situation at Big Bend, vessel movements are one-way. Normal currents vary from 1 to 2 knots. The passage is normally at a slow speed for approaching or leaving the terminals. Slower speeds cause a smaller force to act on the rudder and less response to rudder changes. The result is more difficulty in maneuvering to keep the vessel aligned in the channel. Safe passage with no cross currents to impact vessel movement requires the vessel to remain in the center of the channel to minimized bank suction that can cause maneuvering problems.

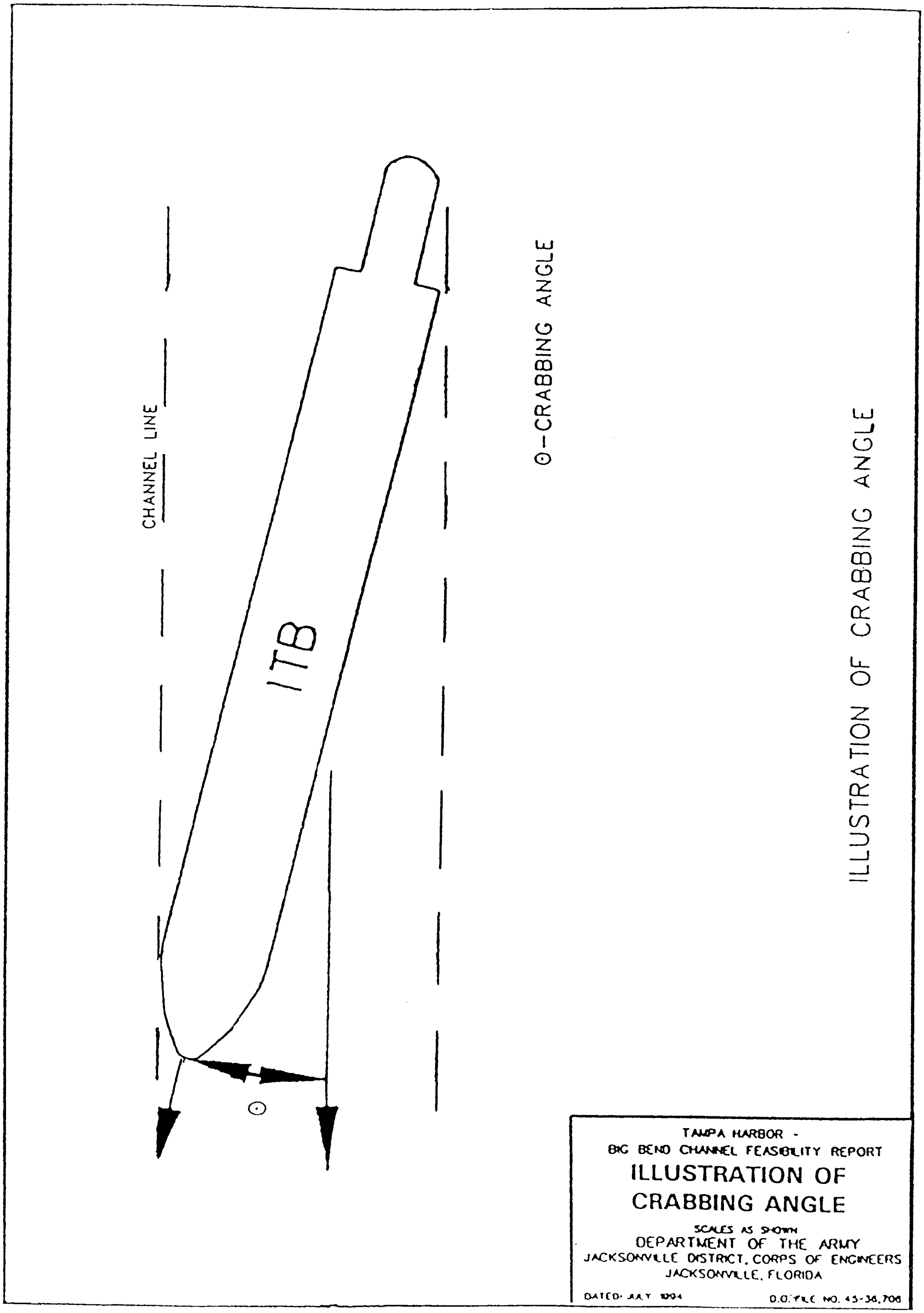

CHANNEL LINE
Θ-CRABBING ANGLE
ITB
Θ
ILLUSTRATION OF CRABBING ANGLE
TAMPA HARBOR -
BIG BEND CHANNEL FEASIBILITY REPORT
ILLUSTRATION OF
CRABBING ANGLE
SCALES AS SHOWN
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

Figure 6

Bottom Width. Vessels that currently frequent the harbor have beams that range from 85 feet for barges to 106 feet for large bulk carriers. The existing channel bottom width is only 200 feet. The margin of safety is less than 50 feet on each side of larger ships with wide beams. The ratio of bottom width to vessel beam is less than 2 to 1 for the larger ships. The pilots prefer a 3 to 1 ratio for lesser risk when maneuvering difficulties occur in the channel. The extra width enables more response time to keep the vessel centered in the channel.

ECONOMIES OF SCALE

Inadequate channel depths and widths are resulting in ever-increasing inefficiencies in the use of the facilities located at Big Bend. Vessels currently utilizing Big Bend Channel are capable of handling more tonnage. Channel depths restrict drafts causing light-loaded conditions (vessels loaded to less than their maximum draft). Such movements are less efficient and result in higher shipping costs which can ultimately have an impact on competition within certain markets and consumer costs.

NEEDS AND OPPORTUNITIES

Opportunities arise from the channel widening which will minimize navigational difficulties associated with vessel transits into and out of Big Bend. Further opportunities exist in the form of advance maintenance since the channel is estimated to have a moderately high annual shoaling rate (80,000 CY per year) with more bottom area. Extra depth enables more shoal capacity to extend the time between maintenance cycles reducing the number performed over a 50 year project life and the overall costs.

Opportunities arise from increasing the efficiency of commodity movements through Big Bend Channel. Increases in efficiency would occur when vessels can carry more cargo per trip to reduce transportation costs and port visits associated with cargo movement. By increasing the amount of cargo per trip, the number of trips per year required to move a given amount of tonnage would decline resulting in less vessel traffic and lower unit costs for cargo transport.

PLANNING OBJECTIVES

The Federal objective in water and land resource planning is to make a contribution toward National Economic Development (NED) consistent with protecting the nation's environment. Specific planning objectives in conducting the study were to determine:

- The nature and extent of the navigation problems at Big Bend;
- The anticipated future navigation needs of the area;
- The resources that would be affected by the navigation improvements; and
- Executive Order 11988 which requires Federal agencies to recognize significant values of the 100-year flood plain and to consider the public benefits that would be realized from restoring and preserving those areas.

ALTERNATIVE PLAN EVALUATIONS

The alternatives included structural and non-structural plans. The structural alternatives involved various plans to consider channel depths, widths and disposal options during the formulation process. The non-structural plan is the most likely future condition without improvement or the "no action plan". A discussion of the various considered alternative plans is in subsequent paragraphs. The analysis is on the future conditions with those alternatives. The paragraphs provide the evaluation results that reduce the number of alternatives in order to identify the best plan for selection based planning objectives.

NO ACTION PLAN

Description. This plan provides nonstructural measures for future management and use of existing port facilities and navigation features in the study area. Maintenance of the existing navigation channels continues and current vessel criteria for entering and leaving the port would prevail with no change. Since Big Bend Channel is not a Federal project and no improvements would be constructed under this plan, maintenance of the existing navigation features continues to be non-Federal.

Discussion. The continuation of maintenance on the existing private project does not address the users need to handle future tonnage and vessel traffic in an efficient manner with minimum risk. The ability to increase efficiency, handle increasing tonnage demand, and reduce transportation costs is very limited for commodity movements on the existing Big Bend project. The plan does not meet the planning objectives set forth in this report but is the most likely base condition without improvement.

BOTTOM WIDENING PLAN

The U.S. Army Corps of Engineers' Waterways Experiment Station (WES) conducted a ship model simulation study on the Big Bend navigation features. That study was a design effort mainly to examine bottom alternatives such as width along the channel, wideners at turns, and turning basin area. The model simulates the forces, acting upon vessels as they transit the channels and turns at Big Bend. The model results are in appendix C as a Memorandum of Record with the subject "Final Findings on Big Bend Channel Navigation Study, Tampa Bay, Florida", dated 20 June 1994, from WES. Ship pilots, licensed for movement of vessels in the Big Bend area, assisted in simulating vessel movements on the model for evaluation and design selection.

Test Vessels. To be representative of the future fleet, the tests used two design vessels, an integrated tug and barge (ITB) unit and a self-propelled bulk carrier. The ITB had an overall length of 760 feet and a beam of 78 feet. The tug portion of the unit was twin screw. The barge had a bow thruster with no tug assistance. The ITB tests were with the barge at a light-loaded draft of 12 feet and a loaded draft of 32 feet. The bulk carrier had an overall length of 740 feet, beam of 105.75 feet, and a draft of 38 to 39 feet. The bulk carrier was single screw and used tug assistance for making turns in the turning basin and at the junction with the Tampa Harbor main ship channel.

Bottom clearances on the bulk carriers will likely remain the same as existing conditions resulting in some changes in bottom forces acting on the hull. Shallow water on each side of the channel causes the pilots to try and keep the vessels in the center of the channel to avoid bank suction. As vessels become wider, the bank clearances on either side of the vessel reduce if the channel width remains the same. That situation means the pilots have less channel area to correct for any unexpected change in vessel direction and a greater susceptibility to bank suction should the vessel deviate from the center area.

Channel Conditions. Model testing involved the existing channel bottom width, turn wideners, and turning basin except in one area. The figures in appendix C did not accurately depict the correct channel bottom limits on the Tampa Harbor main ship channel at the west end of the Big Bend entrance channel. The error is along the western edge of the main ship channel at the junction of A and C Cuts. The figures show a gap between the existing navigation channel markers and western edge of the channel. That is incorrect. The expanded area in figure 7 fills the gap and shows the correct location of the existing channel bottom that follows the markers around the turn.

Modeling Conditions. Model testing identified problems with maneuvering deeper loaded test vessels under existing channel bottom conditions with deeper depths. The ship simulation tracks in appendix C confirmed the areas that port pilot had difficulty staying within existing and corrected bottom width conditions. Model conditions also include design winds which were variable from the north averaging 15 knots.

Problem Analysis. Problems normally occur when water current and/or wind forces influence vessel movement. The impact of those forces is a serious problem in the entrance channel. That is the reach where the pilots reduce the speed of an incoming vessel in preparation for maneuvering and stopping in the turning basin to enter a berth. On leaving the port, the pilot is attempting to gain steerage and momentum in that reach.

When the pilot reduces speed, the vessel's propeller turns at slower revolutions per minute (RPM). The reduced RPMs decrease the water force on the surface of the rudder which reduces directional control of the vessel. That slowing process enables other forces (currents and winds) to become a greater influence on vessel movement. Attempts at maneuvering to overcome these forces are difficult at slower speeds.

Loaded vessels have more momentum and experience more difficulty in maneuvering than unloaded ones. This is due to the larger hull area under water for current forces to influence. Once underwater forces influence the vessel direction, it is very difficult to correct without increasing vessel speed to put more force on the rudder. The smaller the distance between the vessel hull and channel bottom results in greater resistance (bottom suction) to movement. The loaded vessels at Big Bend tend to have little bottom clearance which also causes slower responses in maneuvering.

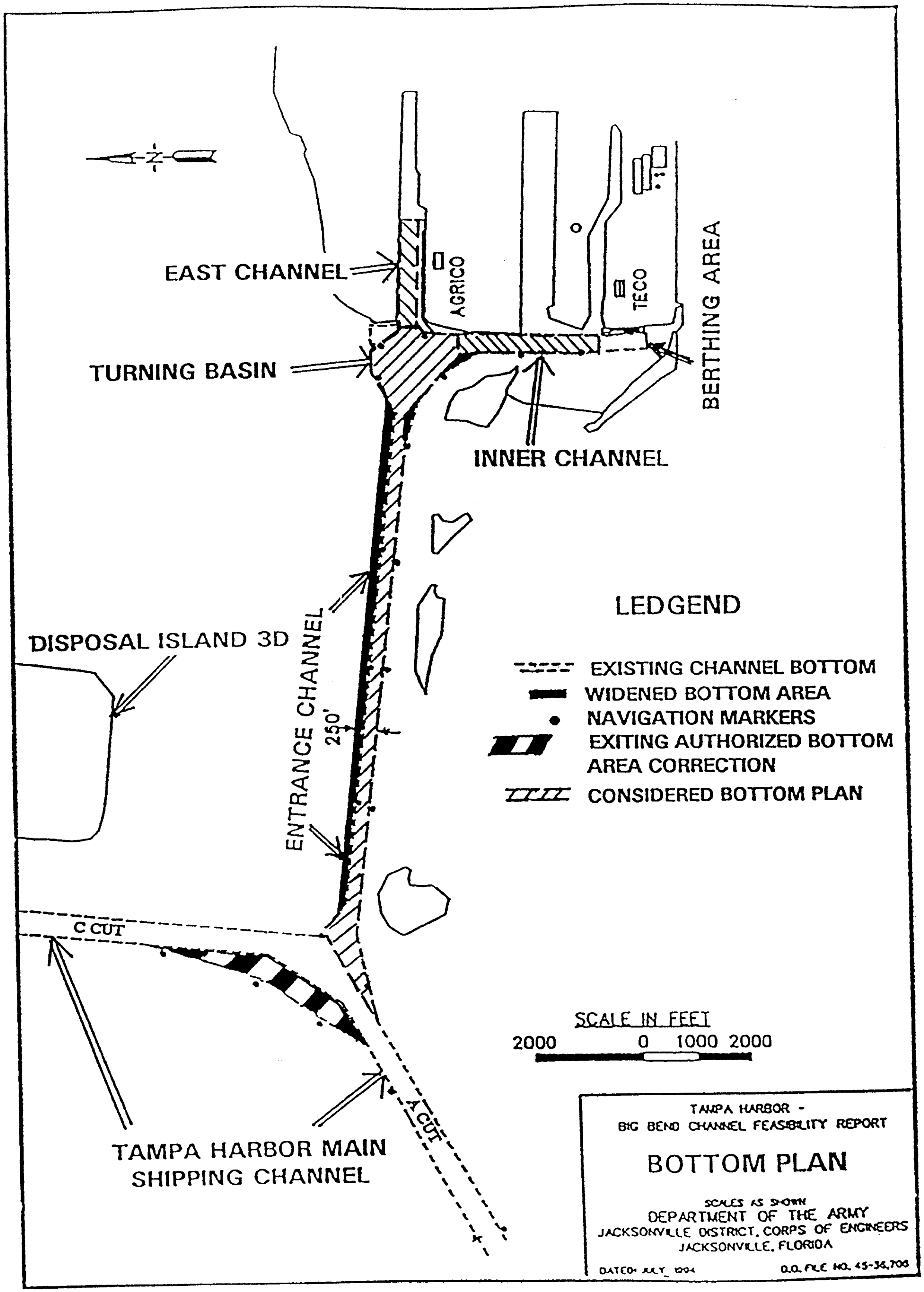

EAST CHANNEL
AGRICO
TECO
BERTHING AREA
TURNING BASIN
INNER CHANNEL
LEDGEND
EXISTING CHANNEL BOTTOM
WIDENED BOTTOM AREA
NAVIGATION MARKERS
EXITING AUTHORIZED BOTTOM AREA CORRECTION
CONSIDERED BOTTOM PLAN
DISPOSAL ISLAND 3D
ENTRANCE CHANNEL
250'
C CUT
A CUT
SCALE IN FEET
2000 0 1000 2000
TAMPA HARBOR MAIN SHIPPING CHANNEL
TAMPA HARBOR -
BIG BEND CHANNEL FEASIBILITY REPORT
BOTTOM PLAN
SCALES AS SHOWN
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

Figure 7

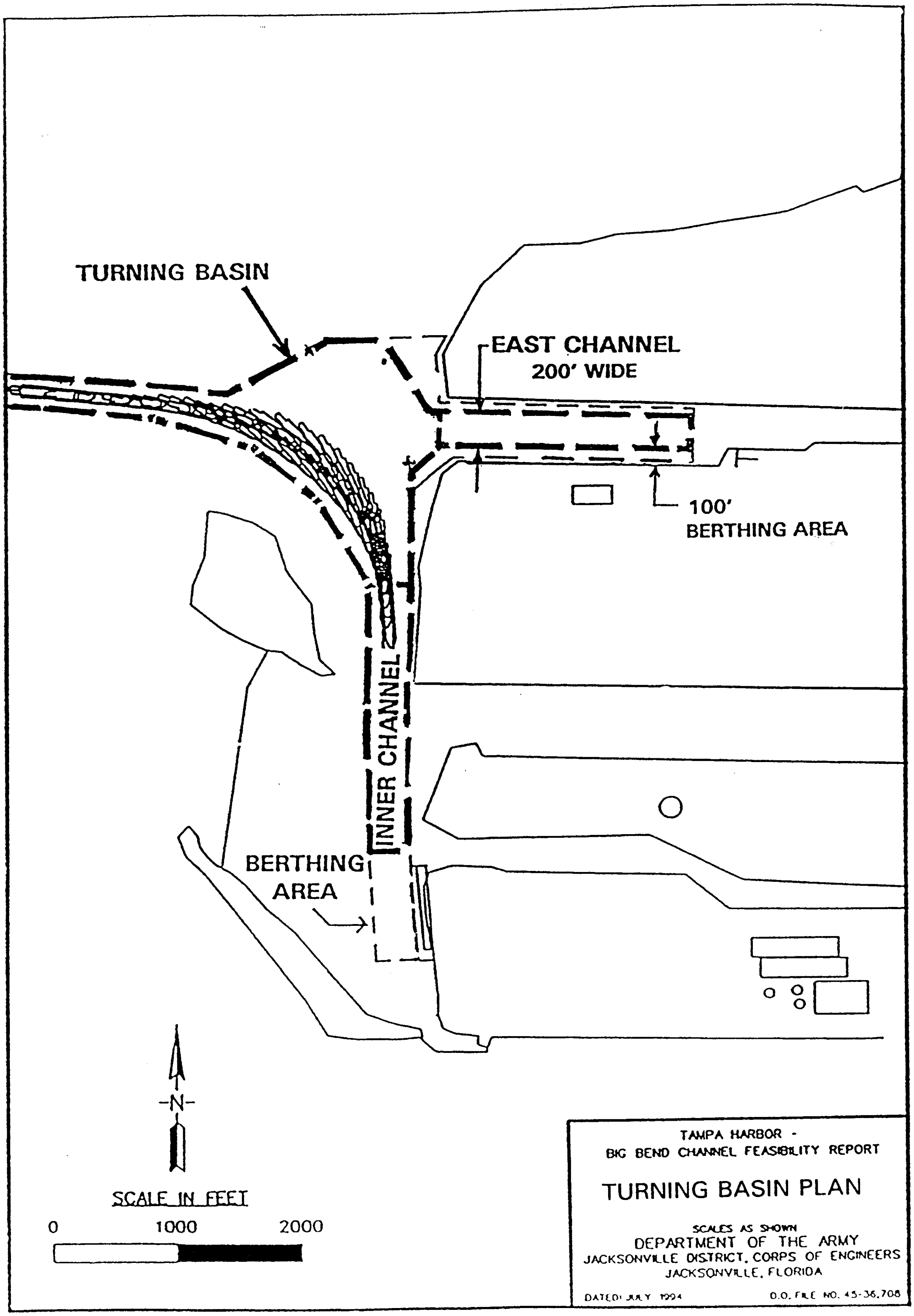
Wind forces have more influence on the unloaded vessels which have more surface area above water. Those vessels normally do not have any problems with bottom suction in their light loaded conditions. With less momentum, the vessels are more easily maneuvered for adjusting to directional shifts. The pilots need to be alert to sudden wind forces and be able to correct before going aground. Again, pilots require the extra channel width to maintain a correct vessel angle to avoid being forced out of the channel by a strong sustained wind.

Test Results. Testing of both design vessels shows the pilots have difficulty in specific areas under certain conditions. Maneuvering problems occurred mainly in the entrance channel and turn on eastern end of that channel. Although the turns between the Big Bend entrance channel and C Cut in the main Tampa Harbor ship channel appeared to be a problem from the figures in appendix C, the adjustment to correct the existing bottom on the main ship channel eliminated most of that problem. The existing bottom width on the inner channel was no problem and is to remain the same.

Entrance Channel Width. The larger, loaded vessel movements under existing conditions have insufficient channel width for pilots to keep them in the channel. Model testing to correct that deficiency considered widening the existing bottom width. Considering the tracks of the vessels, a minimum increase of 50 feet was necessary in the model tests. Provision of that increase is possible in two ways. Plan A added 25 feet both north and south of the existing width. Plan B added 50 feet all to the north. Model results indicated both were safe design conditions but Plan B was more effective and is the WES recommended bottom plan shown in figure 7.

Entrance Channel End Turns. Testing results in appendix C showed vessel tracks in relation to the channel bottom boundaries at each end of the entrance channel. The tracks indicate the pilots are able to keep the vessels within the channel markers except in certain areas. Only those areas that appeared to have sufficient justification and reasonably minimized risk remained in the plan as discussed below.

- East End. The turning basin is on the east end of the entrance channel. The pilots stayed within the existing channel markers except in the turn between the entrance channel and inner channel. The most problem was with the outbound integrated tug and barge (ITB) unit as shown in figures 9-16 in appendix C. The expansion of the widener in figure 8 added the width to enable safer maneuverability as part of Plan B. Figures 17-22 in appendix C show the ship tracks under the widened condition on the east end.



TURNING BASIN
EAST CHANNEL
200' WIDE
100'
BERTHING AREA
INNER CHANNEL
BERTHING
AREA
-N-
SCALE IN FEET
0
1000
2000
TAMPA HARBOR -
BIG BEND CHANNEL FEASIBILITY REPORT
TURNING BASIN PLAN
SCALES AS SHOWN
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA
DATED: JULY 1994
D.O. FILE NO. 45-36,708

FIGURE 8

• West End. The pilots turn the vessels between A and C Cuts on the main Tampa Harbor channel and the Big Bend entrance channel as shown in figures 23-37 in appendix C. The results of the tests are as follows:

- A Cut. The pilots had no problems maneuvering the vessels within the existing bottom area between A Cut and the entrance channel. No changes are required for the turn.

- C Cut. Modification of the existing widener is not necessary on the west side of the Tampa Harbor channel. The pilots made the turns successfully and within existing navigation markers between C Cut and the entrance channel except in one circumstance. That occurrence was in turning an inbound, loaded, bulk carrier into the Big Bend channel from C Cut. The pilots slowed to around one knot and used tugs to stay within the channel. As the likelihood of that movement is rare based on past and prospective usage, benefits from any savings would be small. Shallow water in that area is likely to require an extensive amount of dredging and cost to widen. The small amount of usage does not provide sufficient justification for improvement. Widening in that area is not recommended.

<u>Turning Basin</u>. An expansion of the turning basin to the east beyond the existing markers could be a problem. Port Redwing does not have a bulkhead and water depths adjacent to the shoreline are shallow. Dredging close to the shoreline in that area could result in excessive dredging as side slopes cause loss of land. Depths are already shallow around the northeast marker in the basin. The recommendation is not to expand the basin any farther eastward than the existing marker to the southeast at the entrance to the phosphate terminal as shown in figure 8.

PLAN B - DEEPENING ALTERNATIVES

Figures 7 and 8 show Plan B (existing and expanded bottom area configurations). The areas under consideration for deeper depths are the entrance channel, turning basin, inner channel, east channel, and berthing areas. Depth selection is an economic determination based on the justification for deepening those bottom areas.

An economic analysis compares average annual equivalent (AAEQ) benefits with AAEQ costs for construction and maintenance of Federal and associated projects. That comparison enables a determination as to which depth provides the maximum excess benefits over costs. That depth identifies the National Economic Development Plan. A detailed evaluation of the benefits is in appendix B. Table 3 provides a summary of benefits from that appendix for the various depths under consideration.

TABLE 3

BENEFIT ESTIMATES BY PROJECT DEPTH

Items	Average Annual Benefits ($1,000) by project Depth in feet 1/						
	37	39	40	41	42	43	44
Barge Carriers							
Coal - Domestic Source	32.0	32.0	32.0	32.0	32.0	32.0	32.0
- Foreign Source	20.1	20.1	20.1	20.1	20.1	20.1	20.1
Phosphate Rock	651.9	703.5	703.5	703.5	703.5	703.5	703.5
Granulated Triple Super Phosphate	19.1	19.1	19.1	19.1	19.1	19.1	19.1
Self-Propelled, Bulk Carriers							
Coal	490.1	1,386.8	1,818.4	2,126.4	2,201.6	2,272.0	2,338.0
Granulated Triple Super Phosphate	355.5	413.1	428.4	443.6	449.4	449.4	449.4
Tankers Phosphoric Acid	277.8	373.1	384.1	384.1	384.1	384.1	384.1
Total Benefits	1,846.5	2,947.7	3,405.7	3,728.8	3,809.9	3,880.3	3,946.5

1/ Interest rate and discount rate are at 7.625 percent. Project life for the benefit analysis is 50 years. Vessel operating costs are at 1996 price levels.

Benefits come from transportation savings associated with the future vessel fleet using deeper drafts on considered channel depths for access to Big Bend terminals. The benefit evaluation for transportation savings involved the movement of coal to the Big Bend power plant and the movement of phosphate rock and chemicals from terminal facilities near the turning basin.

The coal and phosphate movements all use the entrance channel and turning basin. The inner channel connects the electric power plant coal terminal to the turning basin. The only movement on that channel is coal. The east channel extends east from the turning basin between Port Redwing and the phosphate terminal berths. Deepening of the east and inner channels is a separable element which considers only the respective bulk movements using them. The analysis of vessel loadings associated with prospective fleets at different channel depths provides the basis for the incremental analysis.

DISPOSAL ALTERNATIVE EVALUATION

Appendix F is a dredged material management plan for the Big Bend proposed project. The objective of that plan is to determine the most cost efficient method of disposal for initial construction and future maintenance over the first 20 years or more on the project. The least cost disposal alternative becomes a part of the National Economic Development (NED) plan. That plan must be consistent with environmental guidelines and regulations for implementation.

Disposal area evaluations in that appendix considered:

- Disposal island 3D,
- Upland areas on the mainland,
- Offshore site for Tampa Harbor,
- Beach placement, and
- Beneficial use areas for dredged material from construction and maintenance of Plan 1.

The subsequent discussion provides a brief summary of the findings in that appendix.

Offshore Dredged Material Disposal Site (ODMDS). The Environmental Protection Agency (EPA) selection process, ongoing for several years, is now complete. EPA has designated a site about 7.6 miles southwest of the entrance marker on the Tampa Harbor Federal Channel. Figure F-1 in appendix F shows the location of the ODMDS.

The Federal emphasis in dredging is to minimize cost consistent with environmental considerations. Estimated excavation and transport of the material for the most efficient cost uses a clamshell for dredging and barges for hauling to the ODMDS. Compared to upland disposal possibilities in the Big Bend area, the ODMDS cost is nearly twice that of upland disposal. That site is too far from the proposed project for economical use.

Beach Nourishment. The material dredged during construction and maintenance is expected to have a high percentage of fines. Such a percentage makes the material unsuitable for placement directly on a beach. Separation of fines is not a cost efficient process to enable suitable material for beach placement.

Disposal on Islands South of Big Bend Channel. Past dredging operations created two islands with two shallow water areas between them. Those areas are parallel with and south of the Big Bend Channel. The two areas are about 3 feet below mean low water (mlw). Environmental agencies strongly oppose any further disposal of material in that area due to the nearby presence of submerged aquatic vegetation and shallow water habitat. Based on the potential adverse environmental impact, that disposal option is no longer a consideration.

Upland Disposal. An analysis of upland alternatives involved over 30 old and new sites in the Big Bend and Alafia River area. About 10 of those sites had significant adverse environmental impacts associated with development resulting in their elimination. Historically, several existing upland areas have been in use within the study area. The two existing sites, one at Alafia River and the other at Big Bend, are for private use with limited capacity. Continued use of the areas is part of the analysis on available capacity for future disposal of material. The remaining sites underwent a cost analysis to determine the least cost alternative. The estimated cost on each of those sites was more than the cost to use disposal island 3D. No further consideration was given to use of those sites.

Disposal Island 3D. The Tampa Port Authority (TPA), as the sponsor of the proposed project, wants to use the island for disposal. Suitable material on the island is not sufficient to increase the dike height 20 feet. Big Bend new work dredging is a source of suitable material for that dike construction on 3D. Placement of initial construction material into that disposal island is the most cost efficient means of getting suitable material for raising the existing dikes.

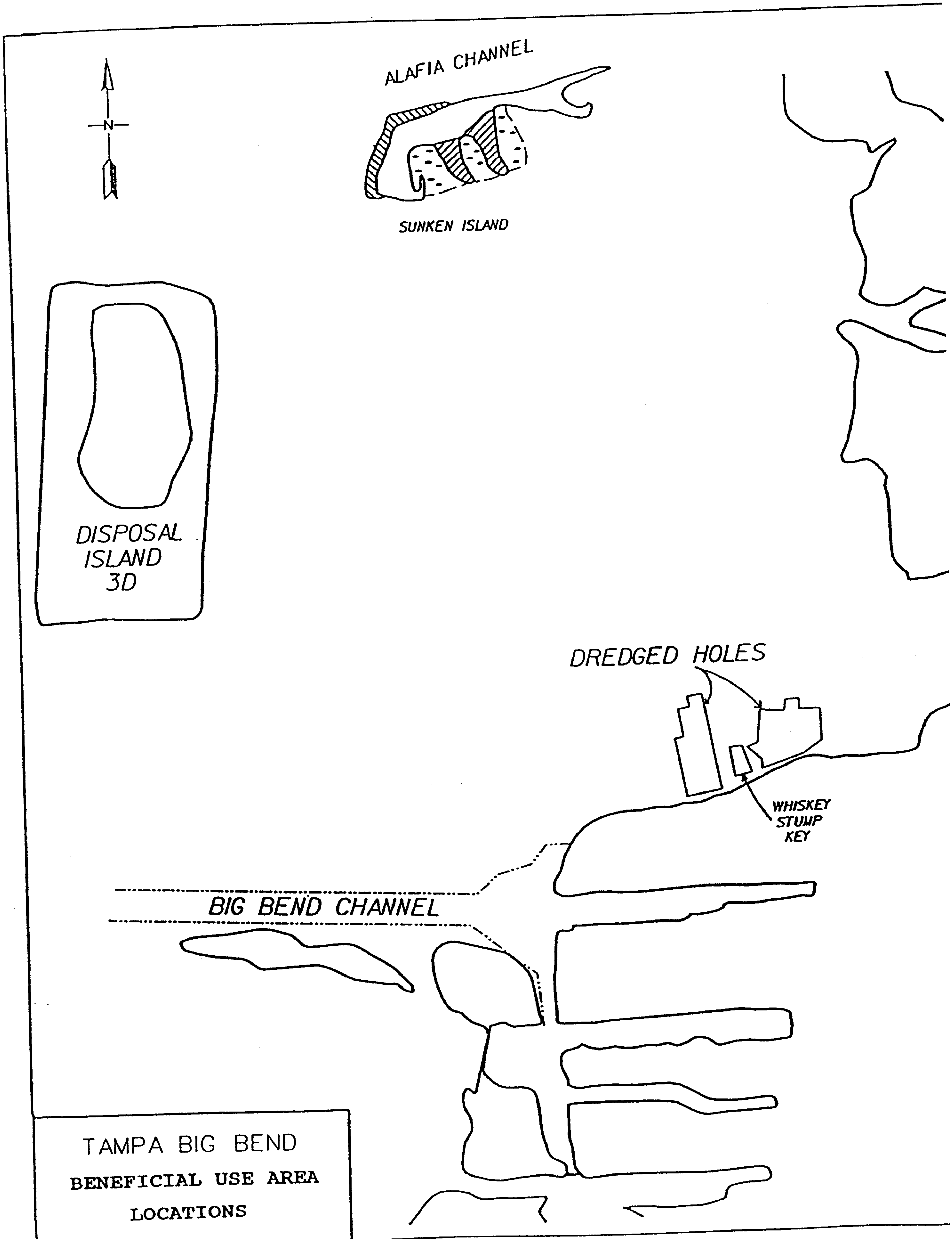
Beneficial Use Sites. The beneficial use of dredged material involves the placement of material in a manner that could enhance the environmental quality of the area. Beneficial uses for dredged material were considered during the formulation of a disposal plan.

The Fish and Wildlife Service suggested two beneficial uses of the dredged material to enhance the environment. A discussion of the potential plans for beneficial use of dredged material is in appendix F. One is to use the material on Sunken Island shown on figure 9. About 545,000 cubic yards of suitable construction material is necessary to implement that plan. The second is to fill holes in the Whiskey Stump Key area shown on figure 9. An estimate of the material needed is about 950,000 cubic yards.

The fine material is likely to be in non-uniform layers and pockets throughout the dredging. Dredging mixes the good course material with the fines. The mixture is a problem because it will probably contain an estimated 40-50 percent fines. That high a percentage is a water quality problem for direct placement into a proposed beneficial use area. The mixture can cause high levels of turbidity that is undesirable in the beneficial use areas without adequate containment for control and separation.

The estimate of material, suitable for enlargement of Sunken Island, does not appear to be of sufficient quantity at this time to repair years of erosion. Filling the borrow holes at Whiskey Stump Key requires an estimated 950,000 cubic yards of material. The current estimates of suitable material appears less than sufficient to fill the holes. A possible solution is to use the fines in disposal island 3D as a substitute for suitable material. The process would involve placing the fines in the holes first then using the suitable material to form a cap over the fines. The amount of suitable material would need to be enough for a minimum thickness of 1-foot. The amount of material for that thickness would require about 80,000 cubic yards. A deeper cap of 3 to 6 feet may be possible if the current estimates of suitable construction material are accurate.

The estimated construction cost for filling the holes involves the movement of about 600,000 CY of fines and 350,000 CY of suitable material from disposal island 3D to Whiskey Stump Key. The added cost for that work, as part of the Big Bend dredging project, is estimated at $6.7 million. To do the work as a separate construction project after the Big Bend dredging has an estimated cost of about $5.2 million. Development of more detailed plans and costs is difficult until after disposal and separation occurs on disposal island 3D. A more accurate estimate will be possible at that time based on actual measurements.



TAMPA BIG BEND

BENEFICIAL USE AREA LOCATIONS

FIGURE 9