will remain on the northern bank of the navigation channel. Maintenance of the channel width would continue to be restricted in that location to avoid impacting the wreck.

6 Formulation of Alternative Plans

Plan formulation is the process of building plans that meet planning objectives and avoid planning constraints. Once the study's objectives and constraints have been identified, many professional disciplines are required to use their knowledge, experience, and judgment to define the combination of management measures that comprise different alternative plans. These plans are then developed in sufficient detail so that a realistic evaluation and comparison of the plan's contributions to the planning objectives and other effects can be identified, measured, and considered.

Plan formulation has been conducted for this study with a focus on contributing to NED with consideration of all effects, beneficial or adverse, to each of the four evaluation accounts identified in the Principles and Guidelines (1983), which are National Economic Development, Environmental Quality, Regional Economic Development, and Other Social Effects. This chapter walks the reader through the development of alternative plans for the Savannah Harbor Expansion Study.

6.1 Planning Goals

Goals are the broad, over-arching purposes for a study. They may be developed from a variety of sources, and given to a study team prior to beginning their tasks. They may be defined by the non-Federal partner or any other stakeholder, and will be unique to each study. The P&G, described in Chapter 1, presents the Federal objective as "…to contribute to national economic development consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements." Generally, the planning goals are the objectives of some organization higher up in the hierarchy. Likewise, the Federal objective is also known as the NED goal to its water resource agencies like the Corps. Therefore, the primary planning goal for this study is to recommend a navigation plan for the Savannah River channel that contributes to the national economic development consistent with protecting the nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements."

The cooperating agencies (USEPA, USFWS, and NMFS) also collaborated on the development of a set of goals related to the planning process and project-related outcomes. These goals are consistent with the Cooperating Agency Vision Statement (see Plan Formulation Appendix), and are listed below.

<u>Cooperating Agency Process Related Goals:</u>

- Determine the specific and differential incremental effects of each channel improvement alternative;

- Identify and evaluate impacts on the human environment, including impacts on natural resources, economics, and societal considerations (jobs);
- Ensure studies are conducted in a manner that leads to their technical acceptance by the scientific community;
- Clearly identify all benefits and costs for the decision-makers;
- Recognize that mitigation may be necessary for any or all of the identified impacts;
- If needed, recommend specific actions that should be taken outside the context of the expansion Project to improve the local environment and/or compensate for past harbor improvement projects. The report would identify the process and participants to accomplish those specific needed actions;
- Document all findings in a report that leads decision-makers to clear decisions on the project.

Cooperating Agency Outcome Related Goals:

- Produce positive economic benefits for the port community and have beneficial environmental effects;
- Include a mitigation plan that addresses unavoidable impacts to critical natural resources;
- Include post-project monitoring to ensure that the expected levels of adverse impacts are not exceeded; and
- Be supported by most stakeholders.

6.2 Project Objectives

After the problems and opportunities were defined (see Chapter 3), the planning objectives and constraints were developed to guide the team's efforts in solving those problems. This section describes the planning objectives for this study.

Planning objectives are statements that describe the desired results of the planning process by solving the problems and taking advantage of the opportunities identified in Chapter 3. The guidelines for the study team in developing planning objectives were that they:

1) Must be directly related to the problems and opportunities identified for the study and will be used for the formulation and evaluation of plans; and

2) Must be clearly defined and provide information on the effect desired (quantified, if possible), the subject of the objective (what will be changed by accomplishing the objective), the location where the expected result will occur, the timing of the effect (when would the effect occur) and the duration of the effect.

The study team worked with many stakeholders to develop objectives for this project. All were helpful insights into their desired outcomes. However, to meet the planning guidelines mentioned above, they were summarized into the following objective:

> Reduce navigation transportation costs to and from the Savannah Harbor to the extent possible over the next 50 years.

Plans should integrate and/or complement other state and agency related programs (including dredged material management and environmental programs) to the extent possible over the next 50 years.

6.3 Planning Constraints

Planning constraints restrict the set of alternative plans developed and also influence the technical investigations conducted during the analysis. The desire to avoid or minimize impacts to natural resources resulted in technical investigations being conducted for dissolved oxygen, salinity, marsh succession, chloride effects at Savannah's industrial water intake, dredged material physical and chemical characteristics, and an investigation of the Upper Floridan aquifer.

The following set of constraints was used to guide the formulation of alternative plans:

- Do not violate maritime safety requirements;
- Do not violate environmental restrictions on dredging;
- Do not significantly impact the Upper Floridan aquifer;
- Do not significantly impact cultural resources;
- Do not adversely impact the landside infrastructure of the Savannah Harbor;
- Do not significantly impact Striped bass recovery;
- Do not significantly impact Shortnose sturgeon; and
- Do not significantly affect dissolved oxygen.

Additionally, the collaborating agencies requested the following be included into the planning process for this study:

- Acknowledge proximity of navigation channel to the Savannah National Wildlife Refuge (sensitivity of the freshwater refuge to potential impacts from future harbor improvements); and
- Refine hydrodynamic and salinity models and conduct additional field studies (as necessary for mitigation of alternative plans).

6.4 Plan Formulation Criteria

Management measures and alternative plans were developed to address the problems identified in Chapter 3: Problems and Opportunities. Each alternative plan is formulated in consideration of four general criteria, as identified in the Principles and Guidelines (1983): completeness, efficiency, effectiveness, and acceptability.

Completeness is the extent to which the alternative plans provide and account for all investments, or other actions, necessary to ensure the realization of the planning objectives, including actions by other Federal and non-Federal entities. **Efficiency** is the extent to which an alternative plan is the most reasonable, least cost means of achieving the objectives. **Effectiveness** is the extent to which the alternatives plans contribute to achieving the planning objectives. **Acceptability** is the extent to which the alternative plans are acceptable in terms of applicable laws, regulations, and public

policies. Appropriate mitigation of any unavoidable adverse effects shall be an integral component of each alternative plan.

Identification of project-specific planning criteria used in USACE project planning is guided by the Principles and Guidelines (1983), the Planning Guidance Notebook, ER 1105-2-100 (22 Apr 2000), and The National Environmental Policy Act (NEPA) of 1969, and Procedures for Implementing NEPA, 33 CFR Part 230. The following technical, economic, institutional, environmental, and social formulation and evaluation criteria have been identified for this study:

Technical Criteria

- The selected plan should be consistent with local, regional, and state goals for water resources development;
- Plans must be realistic and reflect state-of-the-art measures and analysis techniques;
- The optimal scale of project development should be identified by analyzing NED and engineering feasibility;
- The plan should accommodate vessels projected to call at Savannah Harbor during the planning period, based on observed industry operations and reasonable forecasts;
- The plan should maintain existing vessel operability under various weather conditions; and
- The plan should be a product of proven elements and practices which will withstand projected weather and sea conditions, such as storms, floods, and waves.

Economic Criteria

- Each separable unit of improvement should be optimized to provide the maximum net benefits;
- The scope of the proposed development must be scaled to provide maximum net NED benefits. However, departure from the economically optimal (i.e., NED) project is possible in cases where the departure is justifiable and substantiated and an exception is granted from the Assistant Secretary of the Army (Civil Works); and
- There must be no more economical means, evaluated on a comparable basis, of accomplishing the same purpose that would be precluded from development if the Federal plan were undertaken. This limitation applies only to those alternative possibilities that would be physically displaced or economically precluded from development by the project.

Institutional Criteria

- Plans must be consistent with existing Federal, state, and local laws;
- Plans must be locally supported to the extent that non-Federal partner provides a letter of intent stating that it understands its responsibilities and obligations as set forth in the WRDA of 1986, as amended, and related policy;
- Prior to the Preconstruction Engineering and Design (PED) Phase, the non-Federal partner would enter into a written Design Agreement to cost share 25 percent of the costs of the Design Phase upfront. Ultimate cost sharing of design is the same percentage as for construction. Settlement is made at the time of construction, subsequent to execution of the Project Partnership Agreement (PPA);
- Prior to the Construction Phase, the non-Federal partner would enter into a written PPA to provide all items of local cooperation satisfactory to the Secretary of the Army, as mandated by Section 22 of Public Law 91-611, as amended; and
- The GRR and EIS must be approved by the Secretary of the Interior, Secretary of Commerce, the Administrator of the Environmental Protection Agency, and the Secretary of the Army to fulfill the conditions of the project's authorization.

Environmental Criteria

- The plan should minimize the commitment of natural resources, whether they are marine bottom-lands, wetlands, other coastal zones, inland environments, or wildlife in these areas;
- The plan should avoid or minimize environmental impacts and maximize environmental quality in the project area to the extent practicable considering environmental, economic, and engineering criteria;
- A mitigation plan will be developed to fully mitigate any remaining unavoidable adverse consequences which may result from the Recommended Plan;
- The available sources of expertise should be used to identify environmental resources that might be endangered, damaged, or destroyed by plan implementation. These would include the USFWS, USEPA, NMFS, and appropriate state agencies, such as the Georgia Department of Natural Resources and the South Carolina Department of Natural Resources; and
- Measures should be incorporated into the Recommended Plan to protect, preserve, restore, or enhance environmental quality in the project area.

Social Criteria

- The plan should be capable of being integrated into local or regional planning for water and air pollution abatement, transportation, recreation, and land use;
- As much as possible, the plan should minimize noise, dust, odor, unsightliness, and potential health risks;
- The plan should meet existing public health and environmental control standards;
- The plan should not displace, devalue, or destroy important historical and cultural landmarks or sites; and
- Adverse impacts on area recreation resources should be avoided or minimized.

6.5 Management Measures

Management measures are the general categories of actions which are the basis for alternative plan development. The management measures used in this feasibility study were developed through discussions and interviews with GPA, Garden City Terminal operations and management personnel, Savannah Harbor Pilots Association members, and public input. Management measures identified to address the navigation-related problems at Savannah Harbor include operational (i.e., non-structural) measures, locally implemented structural measures, structural measures implemented at other ports, and structural modification of the Federally-authorized channel.

The management measures presented below were assessed for their potential as building blocks of the alternative plans for potential navigation improvements at Savannah Harbor. Equal consideration must be given to structural and non-structural measures during the planning process. Management measures are listed below according to the planning objective they are designed to address and according to whether the measure is structural or non-structural.

1. Management Measure Objective: Reduce tidal delays

    Non-Structural Measures

    - Timing/schedule (dealing with a single vessel only)
    - Reduce under keel clearance requirement
    - Increase efficiency of landside operations to decrease turn-around time
    - Specialization/optimization of facilities
    - Modification of Garden City Terminal
    - Improved traffic management practices (dealing with coordination of multiple vessel movements)

    Structural Measures

    - Regional Port (hub and spoke concept)

- Deeper channel
- Alternate terminal locations
    - Offshore transshipment facility
    - Onshore terminal
- Straighter channel alignment
- Meeting Areas
- Increased/Improved landside infrastructure

2. Management Measure Objective: Improve vessel maneuverability

Non-Structural Measures

- Improved equipment
- Vessel design modifications
    - Thrusters
    - Power
- Tug assistance
- Pilot training
- Aids to navigation
    - Portable GPS navigation system
    - Harbor based vessel control system
    - Range lights/radar reflectors
    - Fixed radar reflectors along channel
- Real time environmental data
    - Real time tide data vs. predicted tide
    - Wind speed and direction
    - Current speed and direction

Structural Measures

- Bend wideners
- Turning basins
- Meeting Areas
- Straighten river/longer ranges

3. Management Measure Objective: Reduce the need to light load caused by channel depth constraints

Non-Structural Measures

- Timing/schedule (dealing with a single vessel only)

- Reduce underkeel clearance requirement
- Increase efficiency of landside operations to decrease turn-around time

- Specialization / optimization of facilities
  - Modification of Garden City Terminal
    - Increase efficiency of landside operations to decrease turnaround time
    - Specialization / optimization of facilities
- Improved traffic management practices (dealing with coordination of multiple vessel movements)

Structural Measures

- Regional Port (hub and spoke concept)
- Deeper channel
- Alternate terminal locations
  - Georgia
    - East Coast Terminal
    - Ocean Terminal
    - Elba Island
    - Brunswick
    - Other
  - South Carolina
    - Disposal Area 12A proposed terminal
    - Disposal Areas 14A/14B proposed terminal location
    - Tybee Island National Wildlife Refuge
    - Other locations
- Offshore transshipment facility
- Onshore terminal
- Straighter channel alignment
- Meeting Areas
- Increased/Improved landside infrastructure

4. Management Measure Objective: Reduce the need to light load caused by operational constraints

Non-Structural

- Timing/schedule (dealing with a single vessel only)
- Reduce under keel clearance requirement
- Increase efficiency of landside operations to decrease turn-around time
- Specialization/optimization of facilities
- Improved traffic management practices (dealing with coordination of multiple vessel movements)

Structural

- Deeper channel
- Alternate terminal locations
    - Offshore transshipment facility
    - Onshore terminal
- Regional Port (hub and spoke concept)
- Straighter channel alignment
- Meeting Areas
- Increased/Improved landside infrastructure
- Create breakwaters

6.5.1 Preliminary Screening of Management Measures

The list of nonstructural measures presented above was assessed on their potential to address navigation problems and opportunities in Savannah Harbor. Most of these measures were screened out due to their ineffectiveness in addressing navigation problems at Savannah Harbor. Additional navigation aid improvements such as buoys and/or navigation markers would not be helpful given the present condition of the harbor and the current configuration of existing navigation aids.

The traffic management system currently employed by the Savannah Bar Pilots includes ship to ship and ship to dispatch communication via radio/telephone as ships traverse the harbor. Each Pilot is in contact with the dispatcher and the other shipboard Pilots as they pilot the ships into and out of the harbor. Ships approaching the Port of Savannah are queued based on the following factors in order of importance (1) draft restrictions, (2) tide jobs/labor costs, and (3) Canal appointments. As each Pilot takes control of a ship he is in contact with the dispatcher and the other shipboard

Pilots as they pilot the ships into and out of the harbor. The Pilots consider this the best traffic management system for the Port of Savannah at this point in time.

The Pilots have looked at a system managed by the US Coast Guard called the Vehicle Traffic Service (VTS). The purpose of a VTS is to provide active monitoring and navigation advice for vessels in particularly confined and busy waterways such as the Houston Ship Channel and Baltimore Harbor. VTS is used to prevent vessel collisions, ramming, and grounding in the harbor and approaches. It is also designed to expedite ship movements, increase transportation system efficiency, and improve all-weather operating capability.

There are two general types of VTS: surveilled and non-surveilled. Surveilled systems consist of one or more land-based sensors (e.g., radar, AIS, closed circuit television) which output their signals to a central location where operators monitor and manage vessel traffic movement. Non-surveilled systems consist of one or more reporting points at which ships are required to report their identity, course, speed, and other data to the monitoring authority.

The Savannah Bar Pilots feel that neither type of VTS would provide a better management system than the system already in place. This does not mean to say the Savannah Bar Pilots are not interested in system improvements. The Savannah Bar Pilots will continue to investigate system improvements as technology improves and congestion increases.

However, two nonstructural measures were carried forward for more detailed evaluation in this investigation (1) reduce underkeel clearance requirements and (2) increase efficiency of landside operations to decrease turn-around time. Both of these measures could potentially reduce lightloading and/or tidal delay costs to vessels that are constrained by existing channel dimensions in Savannah Harbor and are carried forward for more detailed consideration.

The structural measures presented in the previous chapter were also assessed on their potential to address navigation problems and opportunities in Savannah Harbor. The initial screening process of these structural measures was accomplished in the report: "Savannah Harbor Expansion Project Formulation of Alternatives (March 2004)", which serves as an addendum to the Plan Formulation Appendix (Appendix D). A number of structural alternatives were carried forward for further consideration including:

- Alternative terminal locations
    - Georgia
        - East Coast Terminal
        - Ocean Terminal
        - Elba Island
        - Brunswick

        - Other
    - South Carolina
        - Other than Disposal Areas *14A/14B* proposed terminal
        - Disposal Areas *14A/14B* proposed terminal location
        - Tybee Island National Wildlife Refuge
        - Other locations
- Regional Port
- Offshore transshipment facility
- Deepening existing 42 MLLW navigation channel (to Station 103)
    - Alternative 44 (44' Deepening)
    - Alternative 46 (46' Deepening)
    - Alternative 48 (48' Deepening)
- Improve existing 42 MLLW navigation channel
    - Meeting Areas
    - Bend Wideners
    - Aids to navigation
    - Coordination of multiple vessel movements
    - Straighten river / Longer ranges

6.6 Evaluation of Alternative Non-structural Measures

6.6.1 Reduce Underkeel Clearance Requirement

In 1996, a Port Users Workgroup was assembled to coordinate commercial navigation operations in Savannah Harbor. This Port Users Workgroup developed the underkeel clearance requirements currently in effect. The Port Users Workgroup consisted of representatives of the SPA, GPA, shippers, terminal operators, towing companies, and other maritime industry professionals. Also included were the Corps, USCG, and other Federal agencies responsible for safe and efficient navigation on these waterways. The intent of this cooperative partnership between Savannah's port, maritime industry, and government agencies was to proactively implement proven guidelines and operating controls to promote marine safety and to prevent economic and environmental loss. The Port Users Workgroup was cautious not to impose overly restrictive government regulation and controls. As a result of this coordination, the Workgroup developed *Port of Savannah Minimal Underkeel Clearance Guidelines for Minimum Underkeel Clearances*. The guidelines were adopted by parties to the Workgroup as minimum operational standards for vessels transiting Savannah Harbor. These guidelines may be modified in the future by a similar representative body of Savannah's port users.

The underkeel guidelines for commercial vessels are as follows. They are applicable to all vessels in excess of 1600 gross tons.

"The following minimum underkeel guidelines apply in all conditions of tide and weather.

(a) 4 feet for transits in the navigation channel between the sea buoy, across the Savannah Bar, through Jones Island range, ACOE Station –14, where the project depth of the channel increases 2 feet.

(b) 2 feet for transits between Jones Island range and the point in the navigation channel which is adjacent to the facility of destination.

(c) When operating on waters outside the established navigation channel, and while moored at a facility pier, 1 foot for single-skin tank vessels greater than 5,000 gross tons and 6 inches for all other deep draft vessels. These guidelines are also applicable for vessels maneuvering outside the boundaries of the navigation channel."

The Savannah Harbor underkeel guidelines are consistent with other deep-water ports in the United States. Specifically, the ports of New York – New Jersey, Delaware River, Norfolk – Hampton Roads, and Los Angeles – Long Beach require a minimum of three feet underkeel in their harbors.

It is the pilot's decision whether conditions are adequate for a vessel to transit the river at a given time. The Savannah Harbor underkeel guidelines are minimum standards and are not intended to be limiting for pilots, operators, or owners that choose to require a higher degree of safety for their operations. It is also the owners/operators discretion to require that their vessels transit with underkeel clearance in excess of the minimum requirements established by the guidelines. For example, some carriers consider 10% of the vessels' design draft to be a standard rule of thumb for underkeel clearance, which is more than four feet for the largest container ships calling at Savannah Harbor. If a vessel has poor maneuverability, the pilots may require as much as five or six feet of underkeel clearance.

By riding the high tide up or down the river, vessels that are depth-constrained by channel dimensions of Savannah Harbor can achieve additional underkeel clearance, allowing deeper loading or use of a larger vessel. The pilots currently have real-time information about channel depths from National Oceanic and Atmospheric Administration (NOAA) tide gauges, which can be accessed by cell phone. The USACE and port facilities provide the pilots and vessel masters with up-to-date information on channel depths and berth depths, respectively. The pilots are also aware of areas subject to shoaling and the type of material accreted. Much of the substrate of the Savannah Harbor Federal channel is either hard sand or soft mud. Although alternative water level information tools have been implemented in other ports, the pilots are satisfied that NOAA's existing real-time river stage and tide information system provides sufficient information.

The underkeel clearance requirement has officially been in effect since 1996 and was developed by a committee of Port users with competing economic interests, but who all recognize the primacy of safe vessel operations. Extensive discussions with the pilots and the Port community indicate that no additional navigation information or other operational changes would be sufficient to allow systematic reduction of the underkeel clearance requirement. Therefore, this alternative was not considered further.

6.6.2 Modification of Garden City Terminal

As a nonstructural measure, modifications to Garden City Terminal would entail improvements to the container throughput capacity of the terminal beyond those currently projected under without-project conditions. The rationale for this particular nonstructural alternative is that increasing the efficiency of the terminal could potentially decrease the turn-around time for vessels calling at the terminal. Given the growth forecasts for containers moving through Savannah Harbor during the period of analysis, the decreased turn-around time could potentially reduce berth and channel congestion and increase the total number of containers handled at the Port without structurally altering channel dimensions.

Ocean Terminal could not be used to support container operations at Garden City Terminal without its conversion to a dedicated container terminal. The terminals are separated by approximately four miles of city streets, primarily Bay Street which is already very congested. It would not be practical to use Ocean Terminal to provide storage for Garden City Terminal container operations. The conversion of Ocean Terminal to a dedicated container terminal is addressed in Chapter 6.8: Alternative Terminal Locations.

The evaluation of this nonstructural measure is based on its ability to address navigation problems and opportunities in Savannah Harbor. Specifically, it must be determined to what extent this nonstructural measure could address problems associated with channel dimensions which are insufficient to efficiently accommodate the fleet of container ships currently calling on and projected to call on Garden City Terminal in the future.

The viability of modifications to Garden City Terminal as an effective nonstructural measure depends in part on the level of current and future berth congestion. Again, the premise of this measure is that if turn-around time for vessels could be decreased, there might be less berth congestion, allowing depth-constrained vessels greater opportunities to take advantage of the tides and transit the system more rapidly. GPA's Garden City managers indicate that this terminal currently has a berth utilization of approximately 42 percent (based on a 24-hour operation, 365 days/year). Based on industry standards which typically describe 50 percent as full practical berth utilization, this level of berth utilization is approaching full utilization. GPA's build-out plans increase Garden City's TEU handling capacity to 6.5 million TEUs by 2020.

At build-out in 2020, according to the current master plan, the GCT will have 9,700 feet of berth and 560 net acres of container storage area so that facility productivities are projected to be:

- 700 TEU's per berth foot per year in 2020, (formerly 278 TEU's per foot of berth per year in 2006); and
- 11,607 TEU's per net container storage acre per year in 2020 (formerly 5,650 TEU's per net container storage acre per year in 2006).

Berth utilization is expected to be 58% upon completion of Master Plan build-out in 2020.

Additionally, GPA is pursuing an aggressive upgrade of its container handling equipment, which includes a transition to Rubber Tired Gantry cranes (RTGs), which allows a greater concentration of containers per acre. Garden City Terminal currently has 71 RTGs in operation and has a purchasing plan in place to increase to 169 RTGs in operation by 2020. The flow of containers through GCT will be further enhanced by the addition of a new eight lane gate in 2015 and the expansion of existing Gate 4 from 15 to 24 lanes in 2014.

GPA has implemented some portions of the master plan, as the berth length has been already been increased from 8,300 to 9,700 feet. Based on the current levels of facility upgrades and expansion and the projected fulfillment of the Master Plan build-out, there are few if any navigation benefits which would result from additional improvements to Garden City Terminal. It is unlikely that additional improvements to Garden City Terminal would further increase vessel turn-around time to the extent that depth-constrained vessels would have greater opportunities to take advantage of the tides and transit the system more rapidly. Therefore, this non-structural alternative did not receive further consideration.

6.7 Evaluation of Alternative Structural Measures

Structural measures considered for preliminary evaluation include:

- Channel modifications from the sea to Garden City Terminal;
  - Deepening,
  - Widening,
  - Meeting Areas,
  - Expand turning basins,
- Alternative container ship terminal development;
  - East Coast Terminal, GA,
  - Ocean Terminal, GA,
  - Elba Island, GA,

  - Brunswick, GA,
  - Other locations, GA,
  - Disposal Site 12A, SC,
  - Disposal Sites 14A/14B, SC,
  - Tybee Island National Wildlife Refuge (NWR), SC,
  - Other locations, SC,
  - Development of an Offshore Transshipment Terminal, and
- Development of a Regional Port.

Under alternative container ship terminal development measures, channel modifications would be implemented from the sea to an alternative terminal downstream of Garden City but not beyond. As a result of these improvements, Savannah Harbor would have (1) channel dimensions sufficient to more efficiently accommodate Post-Panamax container ships and (2) throughput capacity sufficient to accommodate the anticipated growth in the volume of containers during the period of analysis. The potential appeal of alternative terminal locations is that by being located downstream from Garden City Terminal, dredging costs and possibly environmental impacts associated with saltwater intrusion into freshwater wetlands would be reduced. Construction of a new container terminal in Savannah Harbor (in addition to the existing Garden City Terminal) would be a very expensive undertaking, but it may be possible that cost savings from avoided dredging costs and environmental impacts would out-weigh the additional construction costs.

The alternative terminal locations considered in this investigation (listed above) are illustrated in Figure 6-1, with the exception of the Colonel's Island terminal in Brunswick, Georgia. Port Royal, South Carolina was also identified as a potential alternative terminal location. Port Royal is located approximately 10 miles north of Hilton Head Island along the Beaufort River. This site was eliminated from detailed investigation in this analysis due to geotechnical considerations. Savannah District's Engineering Division discovered that a freshwater aquifer lies close to the surface at Port Royal. This site was not carried forward for detailed investigation due to concerns that deepening the Beaufort River could result in saltwater intrusion into this important source of water supply.

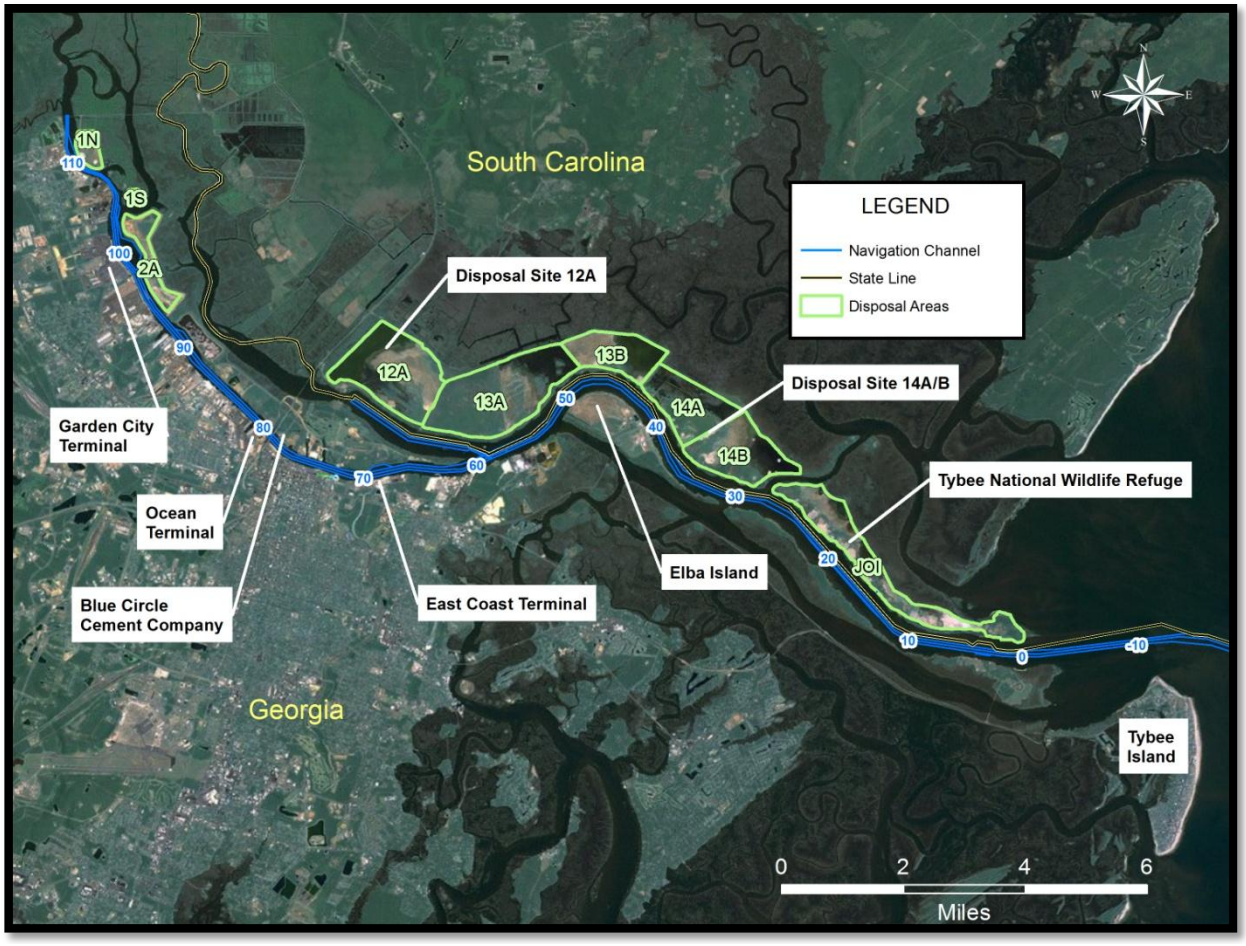

Figure 6-1: Alternative Terminal Locations

To address the navigation problems and opportunities in Savannah Harbor, an alternative terminal would need sufficient capacity to handle the volume of containers anticipated to be carried on depth-constrained container ships. These ships are typically Post-Panamax-class vessels that are consistent with the study Design Vessel (the *Susan Maersk*, an 8,200 TEU Post-Panamax class container ship launched in 1997 (beam: 140 feet, length overall 1,138 feet; design draft: 47.6 feet). It is assumed in this analysis that a new terminal would not eliminate the need for the continued operation of the Garden City Terminal. Instead, the new facility would supplement container handling capacity to help meet the growth in future demand. For this analysis, it was assumed that the new terminal(s) would handle depth-constrained container vessels, and Garden City Terminal would handle container ships that are not depth-constrained by the existing 42-foot channel. It is also assumed that the new terminal would not result in underutilization of Garden City facilities and that costs of such inefficiencies would not be incurred.

It was concluded that a new container terminal would need to be significantly large to achieve economies of scale in facility development, equipment purchase, and terminal operations. To achieve economies of scale, the following mix of facilities and equipment would represent the minimum features for a new state-of-the-art container facility to be an effective and efficient terminal. This mix of facilities and equipment, which are consistent with industry standards, would provide approximately 1.5 million TEU throughput capacity:

- Two berths with an assumed length of 1,250 feet per berth;
- Each will need a minimum of three Super Post-Panamax cranes (with a 72-95 long ton rated capacity);
- Other handling equipment to include: seven Rubber Tired gantries, 10 Five-high loaded Top lifts (87,000 lbs.), and two Seven-high empty stackers (15,000 lbs.);
- 300 acres total, including: 90 acres for container storage, 15 acres of parking space for vehicle storage, 10 acres for service drives and buffer, and 35 acres for container handling marshaling yard for rail loading;
- Annual throughput capacity commensurate with these facilities would be approximately 1.5 million TEUs;
- Dedicated rail access with intermodal rail connection within 10 miles;
- Sufficient landside area for potential future expansion; and
- For existing terminals that would be modified to handle containers or more containers (e.g., Garden City Terminal, Ocean Terminal, East Coast Terminal, Brunswick's Colonel's Island Terminal), 90 acres of container parking would be needed per berth. For these terminals, no additional area would be needed for vehicle storage, service drives, or rail container marshaling.

6.8 Alternative Terminal Locations

The evaluation of alternative downstream terminal locations is largely based on differences in construction costs; although other criteria such as differences in container transportation costs and differences in potential environmental impacts (apart from their associated mitigation costs) are also assessed. All environmental mitigation costs are included in the construction cost estimates. All cost estimates are preliminary level estimates appropriate for screening of potential measures. More detailed cost estimates are developed for measures selected for more intensive investigation and development into alternative plans. Negligible or very marginal differences among the alternative terminal locations were estimated for maintenance dredging costs, terminal operation costs, and potential impact to project benefits. Other differences such as transportation costs and cargo distribution costs are discussed at a cursory level.

6.8.1 Alternative Terminal Locations: Transportation Cost Differences

The location of alternative terminals downstream of Garden City Terminal would result in reduced distances Post-Panamax container ships would need to travel up-river and reduced transit time. These reductions in distance and sailing time would produce lower waterborne transportation costs for vessel using the downstream terminal. These waterborne transportation cost savings would be offset by increased landside transportation costs due to longer over-the-road distances to major cargo distribution points. Containers would have to be transported this additional (compensatory) landside distance using either truck or rail.

Table 6-1 compares waterborne cost savings to additional truck or rail costs. For the purpose of a preliminary screening, the values in the table are based on the simple assumption that the landside transportation distance is equivalent to the reduced river mileage. Each terminal is evaluated for 1.5 million annual TEUs. Waterborne transportation costs per mile are based on a fully loaded 4,000 TEU vessel. Rail and truck costs (per mile) were developed by the Intermodal Association of America, based on the Savannah to Atlanta route. The cost differential may be significantly greater than expressed by these estimates, since per mile truck and rail costs for the Atlanta route (approximately 250 miles by Interstate) are significantly less than costs of relatively slow movements to/from an alternative terminal in the vicinity of the port. All cost estimates are in 2003 dollars.

Table 6-1: Annual Waterborne Transportation Cost Savings and Landside Transportation Cost Increases (2003)

	Reduced Mileage (each way)	Annual Savings in Waterborne Transportation Costs	Minimum Annual Costs Of Compensatory Move by Landside Mode	
			Truck	Rail
Ocean Terminal	3.6	$320,025	$3,898,359	$4,895,613
Blue Circle Site	4.2	$370,555	$4,513,889	$5,668,605
Disposal Site 12A	5.7	$505,302	$6,155,303	$7,729,915
East Coast Terminal	7.2	$640,050	$7,796,717	$9,791,226
Elba Island	11.0	$976,918	$11,900,253	$14,944,503
Disposal Sites 14A/B	11.4	$1,010,605	$12,310,606	$15,459,831
Tybee NWR	15.2	$1,347,473	$16,414,141	$20,613,108

6.8.2 Alternative Terminal Locations: Criteria Evaluation

Each of the alternative terminal locations was assessed for the four criteria - completeness, effectiveness, efficiency, and acceptability - contained in the Principles and Guidelines (1983) and defined below. A "Yes" answer indicated that the terminal met the requirement of the criteria, a "No" answer indicated the terminal did not meet the requirement of the criteria, while a "Marginal" answer indicated that the terminal minimally met the criteria:

- **Completeness** – The extent to which a given alternative plan provides and accounts for all necessary investments or other actions to ensure the realization of the planned effects. This may require relating the plans to other types of public and private plans if the other plans are crucial to realization of the contributions to the objective.
- **Effectiveness** – The extent to which an alternative plan alleviates the specific problems and achieves the specified opportunities.
- **Efficiency** – The extent to which an alternative plan is the most cost effective means of alleviating the specified problems and realizing the specified opportunities, consistent with protecting the Nation's environment.
- **Acceptability** – The workability and viability of the alternative plan with respect to acceptance by State and local entities and the public and compatibility with existing laws, regulations, and public policies.

Garden City Terminal:

- Completeness – Yes;
- Effectiveness – Yes;
- Efficiency – Yes, although there may be some questions with regard to environmental effects;

- Acceptability – Yes; GPA is already in the process of doing things that will allow the port to meet the requirements for future traffic without having to deepen.

Ocean Terminal:

- Completeness – Yes;
- Effectiveness - Yes, while it is not 300 acres, it could be designed to handle the 1,500,000 TEUs as required;
- Efficiency - No, because of the increased traffic and the cost of additional land to make the site adequate. Renovation costs for this site are rather high;
- Acceptability – Marginal, it is questionable as to whether the public will accept the additional traffic created by the movement of additional trucks through that part of the City.

Blue Circle:

- Completeness – Marginal, because of the size of the site and the surrounding land use. Would need to purchase land for the terminal from the Golf Club;
- Effectiveness - Yes, because a terminal with a capacity of 1,500,000 TEUs could be established at the site;
- Efficiency - No, because of the high cost of renovating the site (tear down old facilities) in order to establish a container facility;
- Acceptability - No, because of land issues, the acceptability of having a container terminal on a golf course or in the area of an exclusive development.

Disposal Site 12A:

- Completeness – Yes;
- Effectiveness - Yes, the area can accept a new terminal and move the required number of TEUs;
- Efficiency - No, because of the cost to build a terminal at the site and to bring in the necessary transportation requirements. An impact to the environment could occur if a replacement disposal site is constructed in the surrounding marsh. Those impacts may be avoided if the sediments are used beneficially or deposited in the ODMDS;
- Acceptability - No, because of likely environment impacts and high transportation costs (utility, road and rail access to the site).

East Coast:

- Completeness – Marginal, based the acreage available to the terminal.
- Effectiveness – Marginal, because the area is too small to handle the required container traffic;
- Efficiency - No, because of the additional land costs to bring up the area to minimal acceptance and the cost of turning the facility into a container port;
- Acceptability - No, because traffic to and from the terminal, both rail and truck, would have to pass through the City to get to inland areas served by the port.

Elba Island:

- Completeness - No, the terminal berths would be on a dangerous bend in the River which would affect navigation. Lack of affordable road and rail access;
- Effectiveness - No, because of its location with respect to the channel and safety questions with regard to its co-location with the LNG Terminal;
- Efficiency - No, because of transportation costs;
- Acceptability - No, because of the increased transportation costs, the location of the berths with respect to the channel, and the fact that the terminal would be in the blast zone for the LNG Terminal, a navigation safety problem.

Disposal Area 14A&14B:

- Completeness - Yes;
- Effectiveness – Yes; the area can accept a new terminal and move the required number of TEUs;
- Efficiency - No, because of the cost to build a terminal at the site and to bring in the necessary transportation requirements. An impact to the environment could occur if a replacement disposal site is constructed in the surrounding marsh. Those impacts may be avoided if the sediments are used beneficially or deposited in the ODMDS;
- Acceptability - No, because of likely environment impacts and high transportation costs (utility, road and rail access to the site).

Tybee NWR:

- Completeness - Yes, same as Disposal Area 12A;
- Effectiveness - Yes, same as Disposal Area 12A;
- Efficiency - No, because of the cost to build a terminal at the site and to bring in the necessary transportation requirements. Environmental effects because of the requirement to obtain a replacement disposal area when all of the surrounding area is marsh. Those impacts may be avoided if the sediments are used beneficially or deposited in the ODMDS;
- Acceptability - No, not acceptable from the point of view of the environment and the transportation costs. The site is a National Wildlife Refuge.

Colonel's Island:

- Completeness – Yes;
- Effectiveness – Marginal, because of the distances involved with respect to the port and the inland customers it serves;
- Efficiency - No, because the entire property is wetlands; and the cost of dredging, unknown at this time, may be prohibitive, and transportation costs;
- Acceptability - No, it is unacceptable to Ga. DNR because of the wetlands involved.

Offshore Transhipment Facility:

- Completeness - No, because the size of the structure required to handle the proposed 1,500,000 TEUs, and its establishment in an open ocean environment is not practicable. While there is one such facility in a closed harbor (Hong Kong), and oil rigs exist in the Gulf of Mexico (too small), this is too experimental for this project;
- Effectiveness - No, while it would alleviate some problems it would cause more than solve. The environmental variables, i.e., the minimal wave environment, under which such a facility could operate is on the low end; therefore most of the time the facility would be unable to operate;
- Efficiency - No, the costs for a facility to handle the required TEU's would be very high.
- Acceptability - No, because the cost to build and the operating conditions under which the facility could operate would make it unacceptable to the public.

Table 6-2 contains a summary of the extent to which the Alternative Terminal Sites meet the criteria for alternative plans.

Table 6-2: Evaluation of Alternative Terminal Sites

Site	Completeness	Effectiveness	Efficiency	Acceptability
Garden City	Yes	Yes	Yes	Yes
Ocean Terminal	Yes	Yes	No	Marginal
Blue Circle	Marginal	Yes	No	No
DA 12A	Yes	Yes	No	No
East Coast	Marginal	Marginal	No	No
Elba Island	No	No	No	No
DA 14A/l4B	Yes	Yes	No	No
Tybee NWR	Yes	Yes	No	No
Colonel's Island	Yes	Marginal	No	No
Offshore	No	No	No	No

6.8.3 Alternative Terminal Locations: Cost Evaluation

The alternative terminals are discussed below, moving from upstream to downstream. Discussions include costs anticipated with modification or development of the alternative marine terminals and with channel deepening to -48 feet MLLW from the sea to the terminals. Analyses include quantitative and qualitative considerations of the assets and liabilities of each site. Following evaluations of the alternative terminals, an assessment of the potential for an offshore container transshipment facility and a Regional Port will be presented. The facility costs, dredging costs, and total costs of the alternative terminals along the Savannah River are presented in Table 6-3.

Table 6-3: Facility Costs, Dredging & Mitigation Costs, and Total Costs for Alternative Terminals (2003)

Alternative Terminals	Facility	Dredging & Mitigation	Total Costs
Garden City Terminal	$0	$332,348,000	$332,348,000
Ocean Terminal	$249,907,000	$305,004,000	$554,911,000
Blue Circle Site	$365,301,000	$291,495,000	$656,796,000
Disposal Area 12A	$339,423,000	$192,241,000	$531,664,000
East Coast Terminal	$374,271,000	$203,011,000	$577,282,000
Elba Island	$287,379,000	$138,290,000	$425,669,000
Disposal Sites 14A/B	$358,275,000	$127,089,000	$485,364,000
Tybee NWR	$391,835,000	$79,678,000	$471,513,000
Colonel's Island, Brunswick	$303,876,000	$137,527,000	$441,403,000

NOTE: After conducting more detailed analyses than the Corps performed, the Joint Project Office stated in 2011 that development of a new container terminal in Jasper County would likely cost over $4 billion, due in part to the high cost of transportation corridors. This facility is currently proposed to be constructed at DMCAs 14A and 14B site used in this analysis.

The total costs are carried forward to the summary assessment of the alternative terminals contained in Table 6-4. This table contains facility development costs, dredging costs, mitigation costs, positive and negative aspects of each site, and a summary assessment. All of the alternative facilities are expected to have costs significantly in excess of those which would result from deepening to the Garden City Terminal. For this reason, none of the alternatives to Garden City Terminal were given a "high" assessment in the final column. "Low" assessments were based on negative aspects of the sites outweighing positive aspects. "Medium" assessments were based on positive aspects of the sites outweighing negative aspects.

As indicated in Table 6-4, two sites were assigned a "medium" assessment: Disposal Sites 14A/14B and Disposal Area 12A. Although these sites have significant uncertainties, particularly with respect to environmental effects of landside transportation (rail and road), they have significant positive features as well, even if the total costs for use of these sites do not appear favorable based on this preliminary assessment.

6.8.4 Alternative Terminal Locations: Summary Assessment

Based on the factors described in the analysis and highlighted in Table 6-4, the overall rating of the sites was ranked as a potential deep draft container terminal. The Garden City Terminal was the only one that received a ranking of HIGH. The team gave three sites a MEDIUM ranking, while six sites were judged as having a LOW potential. The extent to which the sites could meet the criteria for an alternative plan was heavily considered in this assessment.

Table 6-4: Summary Assessment of Alternative Terminals

	Total Costs*	Positive Features	Negative Features	Overall Potential
Garden City Terminal	$332,348,000	- Ongoing Container Operation - Access to Rail and Highway - Sufficient area	- Potential environmental impacts	High
Ocean Terminal	$554,911,000	- Close to Garden City - Access to Rail and Highway	- Area may not be adequate for container facility - Associated truck traffic may exacerbate congested streets	Low
Blue Circle Site	$656,796,000	- Highway access	- Area may not be adequate for new container facility - Uncertain rail connection - Could potentially need to relocate existing operation	Low
Disposal Area 12A	$531,664,000	- Sufficient area - Highway access	- Environmental effects: access & replacement disposal capacity - Reduced efficiency of Back River sediment basin	Medium
East Coast Terminal	$577,282,000	- Rail access	- Area may not be adequate for container facility - East-west landside transport - Could potentially need to relocate existing operation	Low
Elba Island	$425,669,000	- Sufficient area - Downstream location	- Safety issues: adjacent to LNG facility - Safety issues: LNG navigation and navigation near LNG terminal - East-west landside transport	Low
Disposal Sites 14A/B	$4,000,000,000	- Sufficient area - Downstream location	- Loss of disposal capacity - Environmental effects: access & replacement disposal capacity	Medium
Tybee NWR	$471,513,000	- Sufficient area - Downstream location	- Environmental effects: site, access, replacement disposal capacity - Potential Intracoastal waterway impacts	Medium
Colonel's Island, Brunswick	$441,403,000	- Sufficient area	- Distance from inland markets - Environmental effects: wetlands disturbance	Low
Offshore Terminal	Unknown	- Potential for regional service - No channel deepening	- Unknown costs of facility - Environmental effects - High costs of double handling - Delays due to weather	Low

NOTE: * These costs were reported in Savannah District's 2005 Formulation of Alternatives Report. In 2011, the Joint Project Office estimated that the cost to develop a new container terminal in Jasper County would be $4 billion, including the land transportation corridors, but not including deepening the shipping channel.

The four sites that were judged as having either a MEDIUM or HIGH potential as a terminal were then compared just on their economics. Table 6-5 shows that comparison. The cost of the next most economically efficient alternative was 42 percent more than the lowest cost site. Therefore, only the lowest cost site (Garden City Terminal) will be considered in the detailed evaluations.

Table 6-5: Evaluation of Higher Ranked Alternative Terminal Sites (2003)

Site	Terminal Construction Cost	Dredging & Mitigation Cost	Total Cost	Incremental Cost (percentage)
Garden City	$0	$332,348,000	$332,348,000	
Tybee NWR	$391,835,000	$79,678,000	$471,513,000	41.8%
DA 14A/14B	$358,275,000	$127,089,000	$485,364,000	46.0%
DA 12A	$339,423,000	$192,241,000	$531,664,000	60.0%

6.9 Development of a Regional Southeastern US Container Port

One alternative considered as a potential solution to the problems outlined in Chapter 3: Problems and Opportunities is the development of a single southeastern US regional container port, which would act as a hub for all other container ports in the southeastern US. A regional southeastern container port would be the port-of-call for the largest container ships, which would arrive from and depart for the largest ports of major trading partners throughout the world. Conceivably, in-bound containerized cargo would be transshipped at the southeast US regional container port from larger Post-Panamax vessels onto smaller container ships which would call at multiple ports along the southeastern US coast. Out-bound containerized cargo would arrive at the Regional Port on Panamax size, or smaller, feeder vessels and be transshipped onto Post-Panamax size vessels for the ocean voyage to the ports of foreign trading partners. This concept is sometimes referred to as a hub-and-spoke operation. The Regional Port is the hub, which would be the jumping off point to the ports of international trading partners. Feeder vessels are the spokes, which ferry cargo back and forth from the hub to local southeastern US ports.

The apparent advantage of a regional southeastern US container port hub is that the economic and environmental costs of deepening channels and developing landside infrastructure would only need to be incurred for a single port, the regional hub, leaving the smaller ports to operate with shallower channels and less intensive infrastructure development because they would be serviced by smaller feeder vessels. Conceivably, many of the southeastern US ports, which would be serviced by feeder vessels under a hub-and-spoke operation, currently have sufficient channel dimensions and landside infrastructure to support the role of a local port in a hub-and-spoke operation.

Although a hub-and-spoke operation may be intuitively pleasing, there are a number of factors which make such an operation, and the development of a southeastern US regional container port, infeasible. These factors include:

- The projected future volume of TEUs which would be handled at southeastern US ports is extremely large and exceeds the total capacity of any of the major US east coast ports;
- USACE participation in planning and constructing a Regional Port would require Congressional authorization and a non-Federal sponsor;
- The lack of a centralized planning jurisdiction which would encourage development of a Regional Port and discourage competitive development of local ports; and
- Local port planning and development is already underway which would make a Regional Port redundant.

In 2006, the major southeastern US container ports handled 6.9 million TEUs. In ten years time, at an assumed annual growth rate of 6%, that volume will nearly double to 17 million TEUs. Using the 2006 Savannah Harbor market share analysis conducted by GPA as a guide, approximately 60% of all TEUs in the ports range are on liner services which would benefit from a deeper channel. In order for this additional volume to be handled by a Regional Port, that port would need to have a throughput capacity of approximately 5 million TEUs in 2016, which is twice the size of Savannah Harbor's current TEU throughput and one million TEUs greater than the current throughput of the nation's third largest container port (New York/New Jersey). In 20 years time, a US regional southeastern Regional Port would need sufficient capacity for 12 million TEUs, which is approximately the 2006 total TEU volume of the nation's two largest container ports (Long Beach and Los Angeles). There is currently no precedent for the construction of a new port of that size, which would necessarily also include extensive landside transportation infrastructure to transship the TEU volumes. In 50 year's time, even more container throughput capacity would be required.

A recent analysis (Economic Appendix, Attachment I: Regional Port Analysis, 2007) assessed the expansion potential of existing southeastern US container ports to see if any single port could reasonably expand to the capacity necessary for a southeastern US Regional Port. The analysis concluded that there was no existing port that could expand container throughput capacity sufficiently to handle the future TEU volume growth projected for the major southeast US container ports. In addition, there are no prospective future port locations which have been identified or proposed which would have the TEU capacity required of a southeastern US Regional Port.

The likelihood of a regional southeastern US hub container port is further reduced by historic and existing port and container terminal development protocols used in the United States. There is no central planning entity which has the jurisdiction to encourage the development of a container port in one location and discourage development of a competitive port in another location.

Container port and terminal development are typically based on perceived local needs and some combination of local public and private funding. Federal involvement is limited to the improvement of publicly available general navigation features (GNF), such as channels and turning basins. While significant, the cost of GNF represents only a minor portion of total port development costs. The extent of the general navigation feature improvement is largely dependent on locally or privately funded port and terminal development and on the commitment of a non-Federal partner to share the costs of the proposed general navigation feature improvement. Port and terminal development is not initiated by the Federal Government. Under existing guidelines and regulations, the Federal Government may only be a partner in the improvement of general navigation features. Local agencies fund port and terminal development.

A third deterrent to the development of a regional southeastern US container port is that local port development initiatives are already underway to address projected future growth in southeastern TEU volumes. The implementation of planned port development projects in the southeastern US would make much of the capacity of a proposed Regional Port redundant, at least for the foreseeable future. Ongoing container port and terminal development in Savannah, Charleston, Norfolk (two terminals), Jacksonville (two terminals), and Wilmington, North Carolina will increase the region's TEU handling capacity by more than 12 million TEUs over the next ten years. Additional container terminals are also being considered which haven't yet progressed beyond conceptual planning and are not included in the ports mentioned above, such as container terminal development at Jasper County on the Savannah River.

Overall, a southeastern US regional hub port has a very low potential for future development because of the large TEU capacity it would require in order to be an effective Regional Port. The large TEU handling capacity would incur large capital outlays and local resource impacts, which would likely be unacceptable. Institutional conditions favor localized port development over regional development, which further decreases the potential for development of a Regional Port. This structural alternative was not carried forward for more detailed analysis.

6.10 Other Channel Modifications (Structural Alternatives)

6.10.1 Meeting Areas

The need for meeting areas was expressed by the Savannah Harbor Pilots subsequent to the preliminary channel design. Meeting areas provide areas for the design vessels to be able to meet in transit to avoid delays that would otherwise be incurred if a vessel had to either wait in the entrance channel or at a dock until a design vessel had exited the channel. For Savannah Harbor, all "passing" lanes are defined as meeting areas. "Passing" is typically defined as ships overtaking each other. "Passing" in this sense is not practiced in Savannah Harbor; therefore, any subsequent reference to

"passing" shall be understood as meeting.

The current design of the Savannah Harbor navigation channel (500-foot minimum width) does not provide sufficient width to accommodate two-way traffic of post-Panamax vessels at any time in the tidal cycle. According to the Harbor Pilots, it is necessary to have fifty feet of clearance between the edge of the navigation channel and the container vessel and one hundred and fifty feet of clearance (the width of another post Panamax vessel) between passing vessels. Adding the width of the vessels and the required clearance shows a minimum required channel width of 514 feet (50+ 132+ 150+ 132+50). If the channel were to be deepened on existing side slopes, as has been proposed, then the minimum width of the channel at its deepest point would be 464 feet with a 48-foot channel, and slightly narrower with each shallower depth alternative.

The addition of an appropriately sized meeting area (a widening of the navigation channel to 600 feet for approximately 6,000 feet) would allow two post-Panamax vessels to meet, as well as the meeting of a post-Panamax and Panamax vessel. The addition of a smaller meeting area could allow meeting of a post-Panamax and Panamax vessel, but would not facilitate the meeting of two post-Panamax vessels in the harbor.

Design trends for the World fleet show a continued growth in the size of individual container vessels over time. The increase in the proportion of these larger vessels in the world fleet and the probability of some of these larger vessels calling on the harbor in the future suggests the need to examine a mid-harbor meeting area. Effective channel design must support the projected fleet, which includes regularly scheduled Post-Panamax vessel calls.

During the beginning stages of the SHEP navigation study, the Pilots initially suggested the Long Island Range (Station 16+500 to 19+500) as a long straight reach that would be appropriate. During the simulation runs, the pilots typically met in the Fort Jackson range using a widened potion of the design channel as a meeting area. As a result, Pilots requested, and the navigation study recommended that the Oglethorpe Range (Station 55+000 to 58+000) be considered as a meeting area being centrally located on a long straight reach.

In a subsequent meeting with the pilots, a need was expressed for a meeting area across from the CITGO dock as pilots experienced delays when vessels are anchored at the CITGO dock. Initial design was a meeting area that ran through Marsh Island Turning Basin (Station 89+134 to 92.000). This area was eventually removed from consideration as attempts to provide more adequate length for a meeting area produced considerable upland taking of real estate.

An incremental analysis of these potential meeting areas is presented in Chapter 11.1: Net Benefits of Alternative Plans.

6.10.2 Bend Wideners

Ship Simulation studies were performed using the Design Vessel, *Susan Maersk.* This vessel is an 8,200 TEU, post-Panamax class container ship launched in 1997. It has a beam of 140 feet, a length overall 1,138 feet, and a design draft: 47.6 feet. The Ship Simulation Report identified ten areas where potential bend wideners could be included in channel design (Table 6-6). Three bend wideners were identified in the ship simulation modeling as being needed to allow safe transit of the Design Vessel. Therefore, the three bend wideners are included in the final channel designs advanced to detailed analyses. Note that widening at the Fort Jackson range occurs on the north side and the south side of the channel.

Table 6-6: Ship Simulation Results: Bend Widening

Range Number	Range/Reach Name	Approximate Station	Simulation Results
0A	Tybee/Bloody Pt.	-41+000 to -38+000	No widening
1A, 2, 2A	Jones Island	-23+000 to -14+000	Widen to the north
6	New Channel/Long Island Crossing	9+500 to 11+500	No widening
9	Lower flats	27+500 to 31+500	Widen to the north
10 to 19	Upper Flats/Bight	31+000 to 49+500	No widening
20	Ft. Jackson	49+500 to 52+500	Widen to the south
20 & 21	Ft. Jackson & Transition	52+500 to 55+000	Widen to the north
24 & 25	Wrecks Channel	65+000 to 66+500	No widening
25,26,27	Wrecks Channel/City Front	69+000 to 71+500	No widening
31	City Front/Marsh Island	76+000 to 78+000	No widening
34 & 35	Marsh Island Turning Basin	87+500 to 90+000	No widening

6.10.3 Straightening of the River

The Harbor Pilots did not identify any portion of the channel where straightening would markedly increase the efficiency of transit. Additionally, Savannah District design staff did not identify a specific area that imposes an undue degree of difficulty in vessel handling necessitating a major straightening of the river. Therefore, this minor modification was not included as a component of alternative channel designs.

6.10.4 Turning Basin Expansion

King's Island Turning Basin adjacent to Garden City Terminal was designed for a 4,000 TEU capacity container ship with a 960-foot length overall. The Design Vessel, the *Susan Maersk,* is an 8,200 TEU vessel with a 1,138-foot length overall. All container ships calling at Garden City Terminal use the King's Island Turning Basin; therefore, turning basin expansion will be included as a component of alternative plans.

6.11 Development of Alternative Plans

An assessment was conducted of non-structural measures (underkeel clearance and modifications to the Garden City Terminal), and structural measures (alternative terminal locations, offshore transshipment facility, passing areas, bend wideners, and straightening of the river). Although the conclusions for those evaluations were included at the end of each separate section, they are summarized here to aid the reader in understanding the rationale for the decisions that the team reached.

Modification to the underkeel clearances used in the harbor was not be pursued in detail as a means of increasing vessel transit efficiency, because the Harbor Pilots do not believe they could operate safely with less clearance. The guidelines used by the Pilots comply with channel design and safety criteria, so there was no need to pursue this feature further.

GPA regularly improves the facilities at the Garden City Terminal, increasing its container throughput capacity. The Ports Authority has several improvements in various stages of planning and indicates it will continue to add to the capacity of that facility as the traffic levels increase. Based on the schedule of improvements already identified and actions the Ports Authority has taken to allow it to expand the capacity of the site even further in the future, additional improvements at Garden City Terminal beyond what will occur under the without project condition are not warranted as part of this project.

Based on the assessment of the alternate terminal locations, the Garden City Terminal is the most economically feasible location to which a channel deepening should be considered. Although dredging costs would be lower to most of the other sites considered, the total costs, including dredging, site development, and transportation corridor costs, would be higher. All the other locations would be more costly methods of serving the expected growth in container volumes. In addition, the expected reduction in environmental impacts with the alternate locations would be lower, when all the effects of developing the alternate site are included. In addition, an effective Regional Port would not be technically or institutionally feasible. There are no existing or planned US east coast ports which could handle the large volume of TEUs which would be handled at a Regional Port, and there is no governing authority which would support development of a Regional Port.

Passing (meeting) areas was included in the alternative plans and was assessed as a component of the incremental cost analysis. This feature is needed to address the effects that the design vessel will have on traffic movements in the interior portion of Savannah Harbor. Under future conditions, Post-Panamax vessels are projected to call regularly at Savannah Harbor. They will likely have an adverse effect on the movement of other vessels transiting the harbor. That effect will be more pronounced for plans which deepen the channel on the existing side slopes. The Harbor Pilots identified the potential locations of two passing areas in the interior portion of the harbor.

Channel design criteria indicate the need to include bend wideners to accommodate the larger design vessel. This need was supported by the Ship Simulation Study. Therefore, the three bend wideners identified as being needed for safe transit of the Design Vessel will be included as features of the alternative channel designs.

No new navigation aids were deemed to be needed to enhance the efficiency of vessel transits through the inner harbor. However, the detailed design of the deeper channel will include an analysis of whether additional buoys or range markers will be needed to mark the deeper channel, and whether the existing aids need to be moved to accommodate the new channel. There will be additional buoys placed on the Entrance Channel extension from Station -60+000 to -98+600B.

Neither vessel traffic coordination nor major straightening of the river was found to be needed, so they were not be included in the final channel design.

No channel modifications features were identified as being needed at this time to enhance Homeland Security. Inbound vessels are presently required to provide 96-hour advance notice, including a manifest of the cargo and crew. The Harbor Pilots already board the vessels offshore, before the vessels reach the coastline. Therefore, a separate boarding area is not considered needed. The final channel design will not contain any features to enhance Homeland Security.

All vessels calling at the Garden City Terminal presently use the Kings Island Turning Basin. It is the largest turning basin in the harbor and is located at the upstream end of the Garden City Terminal. The Hydraulic Design Manual of Deep-Draft Navigation Projects (EM 1110-2-1613) and the project design vessel, the *Susan Maersk,* were used to determine the size to which the Kings Island Turning Basin (KITB) had to be enlarged to accommodate PPX2 vessels. This evaluation indicated that the KITB would need to be enlarged to 1,600 feet long by 1,600 feet wide. The KITB was the only turning basin considered as part of the SHEP. It is the only turning basin within close proximity to GPA's Garden City Terminal where the vast majority of the containerships go. This expansion will be included in the alternative channel designs.

The Sediment Basin is a component of the Sediment Control Works of Savannah Harbor. The Basin is a quiescent area that collects sediments at a relatively high rate. The location of the Basin adjacent to large confined dredged sediment placement facilities allows for sediments to be removed from that location at a lower cost than elsewhere in the harbor. Although originally designed to be at a depth equal to the navigation channel, the Basin was not deepened as part of the 1993/1994 harbor deepening, and it is now 4 feet shallower than the authorized navigation channel. Because of that difference in depth, there was a question as to whether or not the difference in depth between the Sediment Basin (38 feet) and the existing channel (42 ft) was responsible for the decrease in efficiency of the Sediment Basin (approximately 60%).

Further investigations found that the sediment shoaling material in the Sediment Basin was suspended sediment and that the depth difference between the channel and the Basin was not the major controlling factor for Sediment Basin shoaling. The change in shoaling conditions between the periods 1981 – 1985 to 1997 – 2004 was mainly due to an increase in ebb flow velocities which control the depth to which the basin shoals.

After conducting a conceptual level assessment of the effects of further channel deepening, the team agreed to leave the Sediment Basin at its present depth and not deepen that facility as part of this project. Later studies indicated the need to construct a berm near the throat of the Sediment Basin as part of the project's mitigation plan. This would allow the Sediment Basin to gradually fill in with sediment and restrict the flow of more saline water from Front River into Back River. While this would help reduce salinity levels in Back River, it would effectively remove the benefits of the Sediment Basin with respect to sediment trapping and removal. Consequently, any expected increases in yearly channel maintenance costs will be included in the economic analysis of the proposed alternatives.

6.12 Description of Alternative Plans

6.12.1 Plan A – No Action

In this plan, no improvements would be made to the existing Savannah Harbor Federal Navigation Project. This is equivalent to the without-project condition. The navigation channel would remain at its presently authorized 42-foot depth in the inner harbor and 44- foot depth in the entrance channe1. This plan will serve as the basis for comparison of the expected project impacts. It will comprise the environmental and economic conditions that are expected to occur over the 50-year period of analysis. The analysis will include an identification of the type and volume of commodities that are expected to pass through Savannah Harbor if no harbor improvements are implemented. The size and number of vessels that will transport those commodities through the harbor will be identified. Expected changes in the environmental setting will also be identified.

6.12.2 Plan B – Channel Deepening Alternatives

This plan will include several levels of harbor deepening so that an incremental analysis can be performed, as well as an overall determination of the justification of this proposed action. The plan will include several scales, ranging from a 44-foot to a 48-foot channel depth.

- Plan B-44: a 2-foot channel deepening
- Plan B-45: a 3-foot deepening
- Plan B-46: a 4-foot channel deepening
- Plan B-47: a 5-foot deepening
- Plan B-48: a 6-foot channel deepening

The above deepening plans were evaluated with respect to the following channel components:

- **Length of Inner Harbor Channel Deepening:** All alternatives considered would involve deepening the inner harbor channel from the ocean (Station 0+000) to Station 103+000, plus an upstream transition;
- **Channel Width:** Maintain existing side slopes. The existing inner harbor channel is 500 feet wide. The bottom width for the deepened inner harbor would range from 488 feet for the 44-foot project to 464 feet for the 48-foot project. The existing entrance channel width is 600 feet. The bottom width of the deepened entrance channel would range from 588 feet for the 44-foot project to 564 feet for the 48-foot project.
- **Entrance Channel Extension:** The length of the entrance channel extension varies with each project depth and ranges from a 35,682 foot extension for the 44-foot project to 38,600 for the 48-foot project.
- **Turning Basins:** Deepen and enlarge Kings Island Turning Basin to 1,600 feet x 1,600 feet;
- **Bend Wideners**: Use the three bend wideners identified as necessary by the Ship Simulation Study; and
- **Meeting Areas:** Use the three alternative meeting area alternatives incrementally evaluated in the Ship Simulation Study:
    - Long Island meeting area – 8,000 foot meeting area located from approximately Station 14+000 to Station 22+000;
    - Oglethorpe meeting area – 4,000 foot meeting area located from approximately Station 55+000 to Station 59+000;
    - Combination of both Long Island and Oglethorpe meeting areas.

Savannah District used the hydrodynamic and water quality models to identify many of the impacts to natural resources from the proposed project alternatives. These included impacts to salinity, water quality, wetlands, and fisheries. Impacts to other resources were evaluated using separate analyses. Those evaluations included potential impacts to the drinking water aquifer, the City of Savannah's raw water intake at Abercorn Creek, adjacent ocean beaches, riverine shorelines, and air quality.

After the expected impacts to these resources were identified, the Savannah District used the hydrodynamic and water quality models and other assessment tools to evaluate ways to reduce those impacts. A flow re-rerouting plan was developed for each depth alternative that minimized impacts to freshwater tidal wetlands, the resource which the agencies identified as being most at risk from this project, as well as fisheries habitat. The study team decided to adopt the findings of a separate study which identified injection of oxygen as being the best method to remove the incremental effects of the SHEP on dissolved oxygen levels in the harbor.

Using the selected flow-re-routing plans, the water quality model was rerun to determine whether changes would be required to the preliminary design of the oxygen injection systems. Changes were found to be needed, and those changes were included when the models were rerun to identify the remaining impacts to fishery resources.

This iterative modeling revealed that the proposed mitigation features (flow-altering plans and oxygen injection systems) would substantially reduce project impacts to freshwater wetlands, the dissolved oxygen regime, and fisheries habitat. Chapter 8: Alternative Plan Evaluation: Environmental Impacts identifies and discusses the impacts of the depth alternatives after avoiding and reducing project impacts. Substantial adverse impacts would remain to freshwater wetlands, Shortnose sturgeon habitat, and Striped bass habitat even with the flow rerouting plan and the injection of oxygen. Because of those remaining impacts, additional mitigation is appropriate. Those actions are the third step in the mitigation planning process, which are described in detail in Chapter 9: Alternative Plan Evaluation: Mitigation Planning.

7 Alternative Plan Evaluation: Benefits

The NED Procedures Manual Deep Draft Navigation (IWR Report 10-R-4) presents three general examples of NED navigation project benefits, which are based on the conceptual basis for navigation benefits identified in the Principles and Guidelines (1983). The NED Procedures Manual states as examples of navigation benefits (page 11):

"Reduced cost of transportation through use of vessels (modal shift), through safer or more efficient operation of vessels and/or use of larger more efficient vessels (channel enlargement), and through use of new or alternative vessel routes (new channels or port shift)."

The with-project condition transportation cost savings calculated in this analysis are in concurrence with this example presented in the NED Procedures Manual. With-project condition container ship transportation cost savings are based on safer and more efficient operation of container ships resulting from channel enlargement (widening and deepening). The Principle and Guidelines (1983) require that cargo transportation costs include the full origin to destination costs (sec. 2.7.4 (f) Deep-Draft Navigation Evaluation Procedure). The Principles and Guidelines further explain that factors to be considered in the analysis of transportation costs include "available service and schedules, carrier connections, and institutional conditions".

The benefits evaluation includes benefits from channel deepening alternatives based on transportation cost efficiencies and reduced tide-delays. Benefits are also evaluated for construction of meeting areas, which are based on reduced channel congestion delays. Alternative deepening plans are evaluated for one-foot increments of depth from -44 feet MLLW to -48 feet MLLW. Alternative meeting areas, including Long Island and Oglethorpe, are evaluated at the same one-foot depth increments.