



U.S. Army Corps  
of Engineers  
Galveston District

**Galveston Harbor Channel Extension  
Feasibility Study  
Houston-Galveston Navigation Channels, Texas**

*FEASIBILITY REPORT*

**U.S. Army Corps of Engineers  
Southwestern Division  
Galveston District  
February 2017**

## EXECUTIVE SUMMARY

The Galveston District is converting the vertical datum for all navigation projects from Mean Low Tide (MLT) to Mean Lower Low Water (MLLW) in accordance with U.S. Army Corps of Engineers (USACE (2014)), memorandum directing conversion from USACE Headquarters (HQ). The goal of the conversion is to maintain effective depth, rounding channel depths in accordance with USACE (2014). This has resulted in changes in reported authorized channel depths to the new datum. Reference Section 1.7 Vertical Datum for an explanation of the conversion. This report presents all channel depths in terms of the MLLW datum. For the Galveston Harbor Channel Extension (GHCE) Entrance Channel the conversion from MLT to MLLW is one foot deeper, for example where prior reports reference deepening to 45 feet MLT this report will reference 46 feet MLLW.

The GHCE Project, Texas was part of an earlier study for improving the deep-draft navigation channels within the Galveston Bay area implemented pursuant to resolutions of the House Committee on Public Works in April 1950 and in October 1967. The Galveston Harbor and Channel were deepened to a depth of 41 feet pursuant to Section 201 of the 1965 Flood Control Act, as amended (42 U.S.C. 1962d-5), in accordance with the Report of the Chief of Engineers dated November 6, 1970, House Document 92-121, 92<sup>nd</sup> Congress, 1<sup>st</sup> Session (1971).

Subsequently, the deepening of the Houston-Galveston Navigation Channels (HGNC) Project was authorized by Section 101(a)(30) of the Water Resources Development Act (WRDA) of 1996, P.L. 104-303. This authorization included deepening both the Houston Navigation Channel and the Galveston Navigation Channel to a depth of 46 feet, substantially in accordance with the Report of the Chief of Engineers dated May 9, 1996, and the Houston-Galveston Navigation Channels, Texas, Limited Reevaluation Report and Final Supplemental Environmental Impact Statement (1995 LRR) dated November 1995.

Deepening of the Houston Channel to 46 feet was completed in 2005. Deepening of the Galveston Channel did not proceed at that time due to the lack of funds of the Port of Galveston, the non-Federal sponsor on that portion of the HGNC Project. Once funds became available, the benefits and costs of the recommended plan for the Galveston Channel, as identified in the 1995 LRR and authorized by WRDA 1996, were updated by the Houston-Galveston Navigation Channels, Texas, Galveston Channel Project, Final Limited Reevaluation Report, dated May 31, 2007.

The deepening of the Galveston Navigation Channel to 46 feet was completed in January 2011, not including the last 2,571 feet which remained at a 41 foot depth. This remaining 2,571 feet had been evaluated for deepening to 46 feet in the 1995 LRR but was determined not to be economically justified at that time since no portside facilities were in place. In the intervening years, conditions changed, and beginning in 2006 portside service facilities began operating and utilizing the 41-foot channel. In addition, there are now two end users, Gulf Sulphur Services and Texas International Terminals.

In order to continue the study to evaluate deepening the last 2,571 feet of Galveston Harbor Channel, the Port of Galveston entered into a new Feasibility Cost Share Agreement (FCSA) with the U.S. Army Corps of Engineers on February 29, 2016, pursuant to Section 216 of the Flood Control Act of 1970 (33 U.S.C. 549a). The plan recommended by this feasibility report involves extending the 46 feet deep Galveston Harbor Channel the remaining 2,571 feet to reach the end of the limits of the authorized and currently maintained 41-foot channel.

The results of the economic analysis show that there is an economically rational justification to deepen the Galveston Harbor Channel to 46 feet through the reaches that are presently authorized to 41 feet. The average annual cost is \$585,000 for a 46-foot channel at the current interest rate of 2.875 percent.

The benefit-cost ratio (BCR) was determined by comparing average annual benefits to the corresponding average annual costs. The 46-foot channel has the highest net benefit results and an expected BCR value of 2.7 at the current interest rate of 2.875 percent. The estimated fully funded total cost of the project is approximately \$16 million.

Environmental impacts are expected to be negligible because construction will occur within the existing project footprint which is regularly dredged for routine operations and maintenance (O&M), and an existing upland confined placement area (PA) will be used.

This project is in support of two of the four goals for USACE contained in the latest (as of 1 May 2015) USACE Campaign Plan. This plan is available on the internet at the following address:

<http://www.usace.army.mil/about/campaignplan.aspx>. Specifically, this project supports Goal 2 (Transform Civil Works) and Goal 4 (Prepare for Tomorrow).

**Galveston Navigation Channels, Texas  
Galveston Harbor Channel Extension Project**

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# **Galveston Harbor Channel Extension Feasibility Study**

## **Houston- Galveston Navigation Channels, Texas**

### **1.0 INTRODUCTION**

#### *1.1 Purpose of Report/Study Authority*

The Galveston Harbor Channel Extension (GHCE) study authorization is Section 216 of the Flood Control Act (FCA) of 1970, P.L. 91-611, which authorizes the Secretary of the Army to review existing USACE constructed projects due to changes in physical and economic conditions and report to Congress recommendations on the advisability of modifying the structures or their operation, and for improving the quality of the environment in the overall public interest. This current Feasibility report presents an evaluation of extending the 46 feet deep Galveston Harbor Channel the remaining 2,571 feet (Station 20+000 to Station 22+571) to reach the west end of the limits of the authorized and currently maintained 41-foot channel.

An Environmental Assessment (EA) was prepared and has been updated to document changes in existing conditions and species listings in accordance with the National Environmental Policy Act (NEPA).

#### *1.2 Existing Conditions*

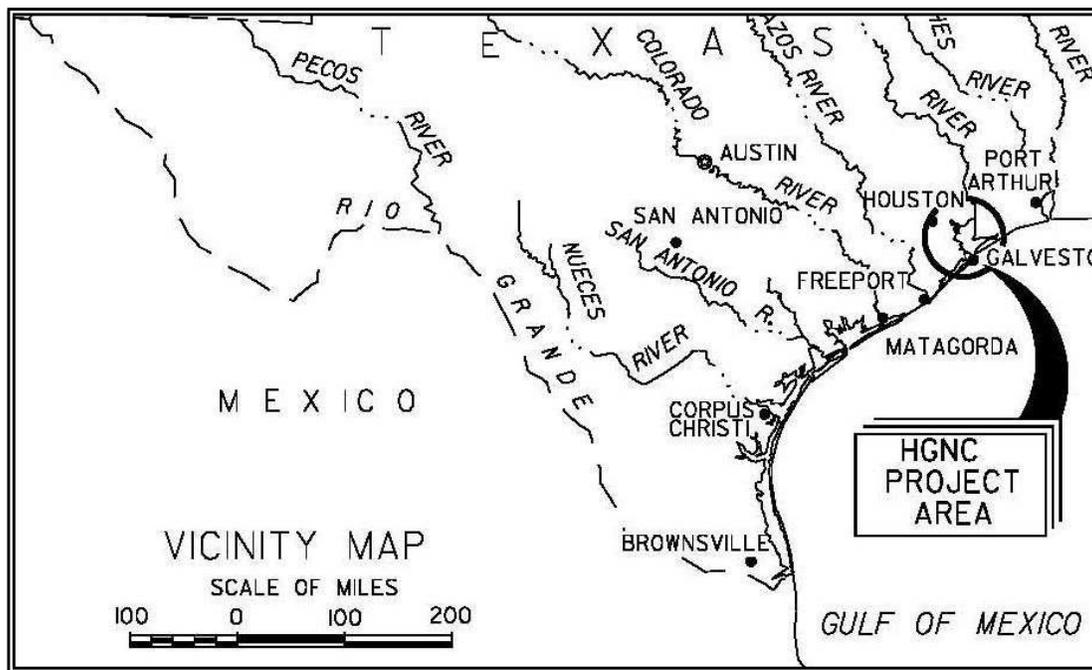
The project area includes the eastern end of Galveston Island and Pelican Island. Galveston Island is a low-lying barrier island two miles off the Texas coast and approximately 50 miles southeast of Houston, Texas. Galveston Island was formed as an offshore bar at the beginning of the present sea-level stand and grew through the accretion of sand from littoral drift. Pelican Island, a natural sand-spit, has been expanded substantially over the years through the placement of dredged material from maintaining the Galveston Harbor and Texas City Channels; a practice which has continued to the present. The Galveston Harbor Channel is a very active shipping lane providing deep-draft vessel access to the Port of Galveston, an important Texas deep-water port. This channel, inclusive of the portion that will be deepened, is lined with various wharves, docks and commercial and industrial facilities associated with Port of Galveston (POG) operations and other port users. Texas City, an important Gulf port city and producer of refined petroleum products, is located approximately seven miles from the project area.

The Galveston community has a diversified income base; however, jobs are predominantly dependent upon tourism, the Port of Galveston, commercial fishing, the University of Texas Medical Branch, and the American National Insurance Company.

### 1.3 History of Project

Galveston Bay, the largest inland bay on the Texas coast, is an important commercial and recreational fishing resource and provides access to the deep-water ports of Houston, Texas City, and Galveston. The Houston and Galveston Channels traverse the Galveston Bay area. This area is located along the northeastern Texas coastline as shown on Figure 1.

The Galveston Harbor and Channel, Texas, Project was part of an earlier study for improving the deep-draft navigation channels within the Galveston Bay area authorized by a resolution of the House Committee on Public Works in October, 1967. This resolution authorized a review of previous reports on the Houston Ship Channel (HSC), Galveston Harbor Channel (GHC), and the Texas City Channel. The channels at this time were 37 feet in depth.



**Figure 1 - Houston-Galveston Navigation Channels Project Location on Texas Coastline**

The Galveston Bay Area Navigation Study (GBANS), Feasibility Report and Environmental Impact Statement (EIS) for improving the Houston and Galveston channels was completed in 1987, and recommended that the Galveston Harbor and Channel be deepened to 51 feet and widened to 450 feet to provide access to deeper water in the Gulf of Mexico. Issues raised during the Washington review of the 1987 GBANS resulted in a decision by the Assistant Secretary of the Army for Civil Works (ASA (CW)) that a reevaluation study would be performed.

A limited reevaluation report (LRR) was completed in November 1995 and made recommendations for project implementation. The Port of Houston Authority (PHA) and the City of Galveston were the non-Federal sponsors of the Houston-Galveston Navigation Channels, Texas Project (HGNC). By letter dated May 24, 2006, the NFS for the project transferred from the City of Galveston to the Board of Trustees of the Galveston Wharves (Port of Galveston, (POG)).

The 1995 LRR presented a plan that consisted of deepening and widening the HSC and deepening of the Galveston Harbor and Channel in two phases. Phase I consisted of deepening the channels to a depth of 46 feet; Phase II further proposed deepening the channels to 51 feet. Environmental studies were conducted at that time to assess the impacts of a 51-foot channel; however, it was later determined that deepening the channel to 51 feet was not economically justified.

Deepening of the Houston portion to 46 feet was completed in 2005. Deepening of the Galveston Channel did not proceed at that time due to the NFS lack of funds. Once funds were available, the benefits and costs of the Recommended Plan as identified in the 1995 LRR and authorized by WRDA 1996, were updated by the *Houston-Galveston Navigation Channels, Texas, Galveston Channel Project, Final Limited Reevaluation Report*, dated May 31, 2007, (2007 LRR). The 2007 LRR updated project design, cost, benefits and environmental impacts specifically related to the Galveston Channel Reach. The 2007 LRR recommended plan consisted of deepening portions of the Galveston Harbor Channel to 46 feet from Station 0+000 to Station 20+000 (2.16 miles) with a bottom width varying from 650 to 1,112 feet and a side slope of 1 vertical to 3 horizontal. Deeping was completed in January 2011, not including the last 2,571 feet which remained at a 41 feet depth.

#### *1.4 Current Study*

On February 29, 2016 a new FCSA was signed between USACE and the Board of Trustees of The Galveston Wharves to resume investigations on deepening the remaining 2,571 feet of the GHCE from 41 feet to 46 feet under this Feasibility Study.

#### *1.5 Authorization*

**Table 1: Authorized Project Features for HGNC Project**

<b>Date</b>	<b>Project and Work Authorized</b>	<b>Documents</b>
October 12, 1996	The project for navigation and environmental restoration, Houston-Galveston Navigation Channels, Texas: Report of the Chief of Engineers, dated May 9, 1996, at a total cost of \$298,334,000, with an estimated Federal cost of \$197,237,000 and an estimated non-federal cost of \$101,097,000, and an average annual cost of \$786,000 for future environmental restoration over the 50-year life of the project, with an estimated annual Federal cost of \$590,000 and an estimated annual non-federal cost of \$196,000. The removal of pipelines and other obstructions that are necessary for the project shall be accomplished at non-federal expense. Non-federal interests shall receive credit toward cash contributions required during construction and subsequent to construction for design and construction management work that is performed by non-federal interests and that the Secretary determines is necessary to implement the project.	Water Resources Development Act 1996, Section 101(a)(30), P.L. 104-303
October 27, 2000	That the Secretary of the Army, acting through the Chief of Engineers, is directed to design and construct barge lanes at the Houston-Galveston Navigation Channels, Texas, project immediately adjacent to either side of the Houston Ship Channel, from Bolivar Roads to Morgan Point, to a depth of 12 feet with prior years' Construction, General carry-over funds.	Energy and Water Development Appropriations Act, 2001, P.L. 106-377, Section 1(a)(2) Appendix B - H.R. 5483, 106 <sup>th</sup> Congress

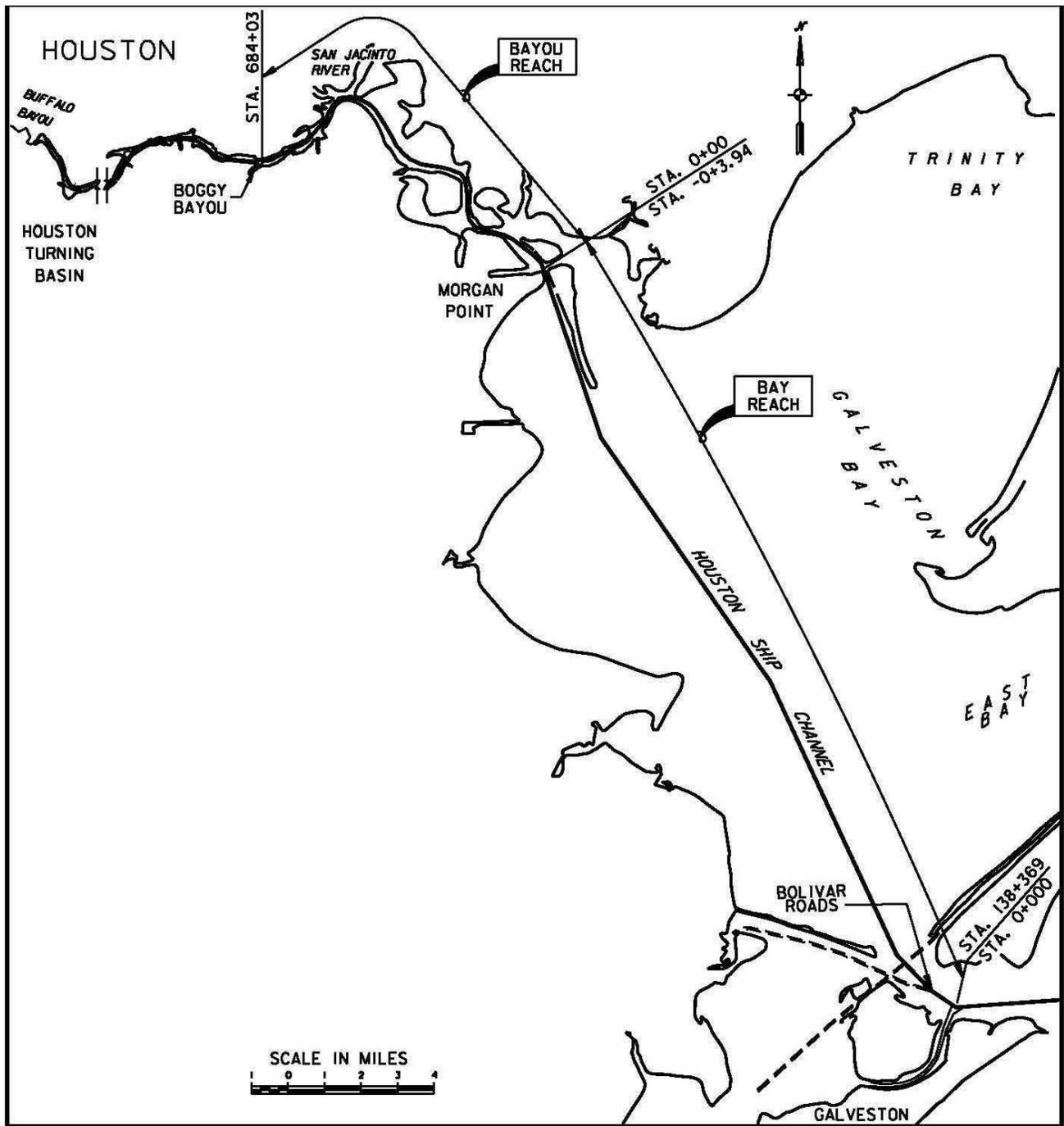


Figure 2 – Map of Houston Portion of HGNC Reach Designations

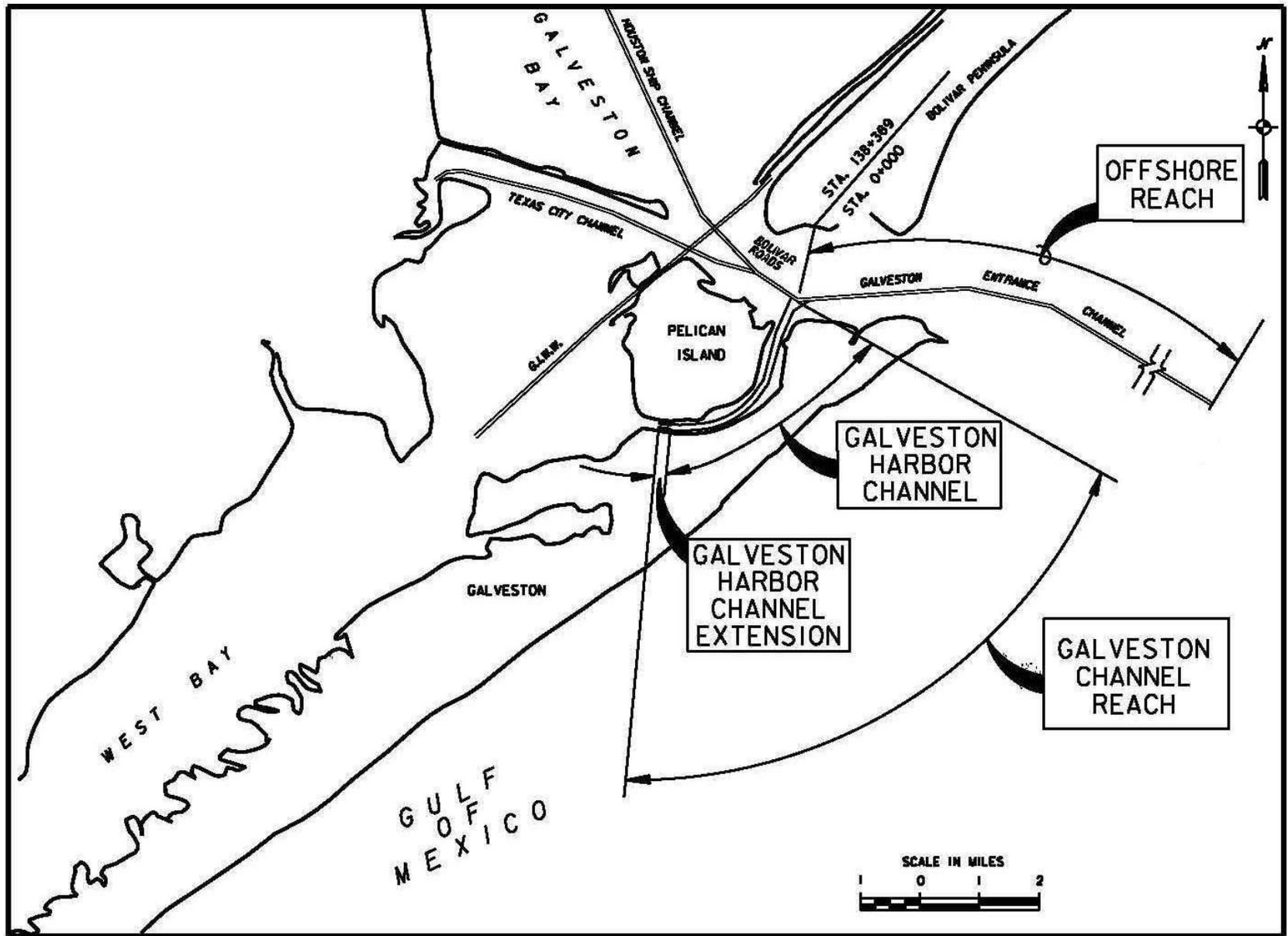


Figure 3 – Map of Galveston Portion of HGNC Reach Designations

## 1.6 Description of Previously Authorized Project

Additional information pertaining to the Station numbers, depths, bottom widths and channel lengths for the GHCE channel reaches is presented in Table 2. The term “Station” refers to a horizontal distance in feet measured along the centerline of the channel and is used to indicate the relative location of a particular portion of the channel.

**Table 2: Approximate Channel Segments for the GHCE Reaches**

Reach	Channel Segments and Station Numbers for Each Reach of the GHCE Project	Depth (Feet below MLLW)	Bottom Width (feet)	Channel Length (feet)	Channel Length (miles)
<b>Galveston Harbor and Channel portion of the HGNC Project</b>					
Offshore Reach (Galveston Entrance Channel)	Extended Entrance 55+840 to 76+000	48	800	20,160	3.8
	Entrance 30+515 to 55+840	48	800	25,325	4.8
	Outer Bar 21+753 to 30+515	48	800	8,763	1.7
	Inner Bar 4+490 to 21+753	46	800	17,262	3.3
	Bolivar Roads 0+000 to 4+490	46	800	4,490	0.8
Galveston Channel Reach (Galveston Channel)	Galveston Harbor Channel (from Bolivar Roads to Pier 9)† 0+000 to 8+000	46	Varies 650–1,133	8,000	3.9
	Galveston Harbor Channel (from Pier 9 to Pier 38) 8+000 to 20+000	46		12,000	2.3
	Galveston Harbor Channel (from Pier 38 to 43 <sup>rd</sup> Street)†† 20+000 to 22+571	41	1,085	2,571	0.5

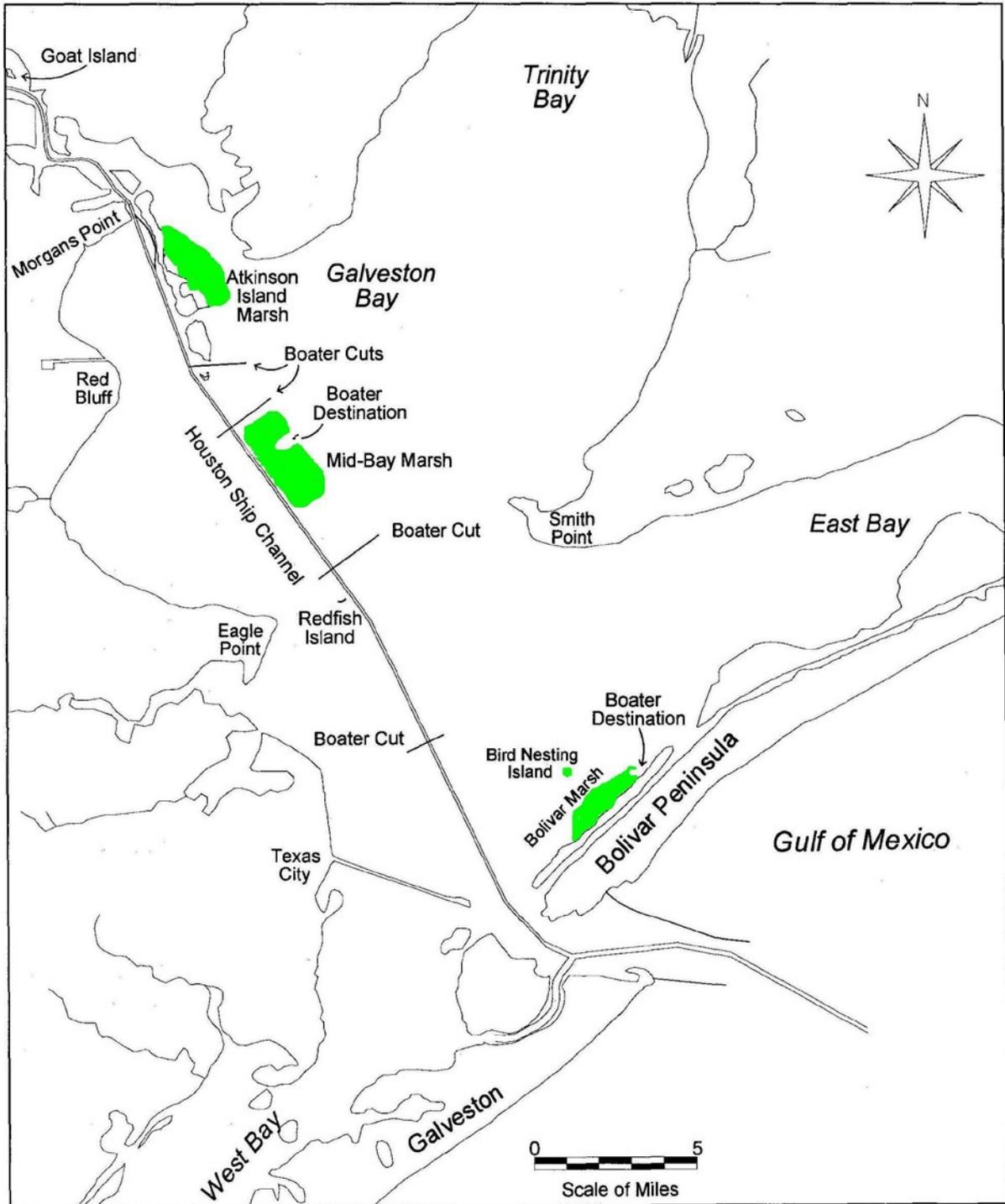
† The existing 46-foot Galveston Harbor Channel terminal end at Station 20+000 functions as a turning basin as it encompasses the entire width and length of the channel which is 1,075 feet wide by approximately 4,700 feet in length.

†† The section of Galveston Harbor Channel referred to in this document as the Galveston Harbor Channel Extension was not included in the 1995 LRR project/HGNC Project and is not reflected in channel length total.

Dredged material from the Offshore and Bolivar Roads area (see Figure 3) was designated to be deposited in the Gulf, within a beneficial use berm and in an Ocean Dredged Material Disposal Site (ODMDS). Material from the Galveston Channel Reach and the Bayou Reach of the HSC was authorized for placement in upland, fully confined placement areas (PAs). Material from the Bay Reach was designated to be used beneficially for the environmental restoration plan described below.

The environmental restoration portion of the authorized HGNC consists of the initial construction of tidal marsh habitat and a colonial waterbird nesting island through the beneficial use of new work dredged material, and incremental development (deferred construction) of additional marsh habitat through the beneficial use of maintenance materials dredged from Galveston Bay. The

HSC portion of the HGNC involved environmental restoration and navigation; whereas, the Galveston portion of the HGNC only involved navigation. Figure 4 shows the location of the environmental restoration features for the HSC portion of the HGNC.



**Figure 4 – Environmental Restoration Features for the HSC portion of the HGNC**

Responsibility for the Offshore Reach is shared by both of the current NFSs of the HGNC. The Bay and Bayou Reaches are the responsibility of the PHA, and the Galveston Channel Reach is the responsibility of the POG.

### 1.7 Vertical Datum

Army regulations and U.S. Army Corps of Engineers (USACE) Headquarters guidance on tidal datum, provided in Engineering Technical Letter (ETL) 1110-2-349 *REQUIREMENTS AND PROCEDURES FOR REFERENCING COASTAL NAVIGATION PROJECTS TO MEAN LOWER LOW WATER DATUM*, dated April 1, 1993, and Engineer Manual (EM) 1110-2-1003, April 1, 2002, stress the necessity of converting local datum, such as mean low tide (MLT) to mean lower low water (MLLW). EM 1110-2-1003 further states that MLLW should be tied to the North American Vertical Datum of 1988 (NAVD 88). The predominate reasons for conversion to MLLW is the need for consistency throughout the ports of the U.S., to enhance the continuity of National Oceanic and Atmospheric Administration (NOAA) and U.S. Coast Guard (USCG) navigation charts and to avoid misconceptions within the shipping and dredging industries with regard to channel depths.

The Galveston District has recently converted the local Mean Low Tide (MLT) datum to the Mean Lower Low Water (MLLW) datum. Reference the *Draft MLT to MLLW Vertical Datum Conversion: Galveston Harbor, Texas City Ship Channel, Houston Ship Channel, Engineering Documentation Report, June 2015* (2015 MLT to MLLW EDR). The calculated MLLW datum for the Galveston Harbor Channel Project is 1.18 feet above zero MLT at the Texas Coastal Ocean Observation Network (TCOON) Gage 1450 (Galveston Pier 21). The calculated conversion was rounded to the nearest foot for application to authorized channel depths. The elevations in this appendix and Feasibility report have been converted to MLLW except as noted as MLT. Engineering analysis done prior to the datum conversion have remained in MLT. The Vertical Tidal Datum Table below provides the depth conversion relationship between MLT to MLLW for the existing GHC.

<b>TABLE 3: VERTICAL TIDAL DATUM CONVERSION</b>				
<b>Project Name</b>	<b>Station Nos.</b>	<b>Project Depths MLT, ft</b>	<b>Project Depths MLLW, ft</b>	<b>Conversion from MLT to MLLW, ft</b>
GHC	0+000 to 20+000	-45	-46	-1
GHC	20+000 to 22+571	-40	-41	-1

Additional References for consultation during Pre-Construction Engineering and Design (PED) may include the following post-2003 guidance pertaining to tidal datum:

1. ER 1110-2-8160, “Policies for Referencing Project Elevation Grades to Nationwide Vertical Datums”, dated March 1, 2009;
2. Engineer Circular (EC) 1110-2-6070, “Guidance for a Comprehensive Evaluation of Vertical Datums on Flood Control, Shore Protection, Hurricane Protection, and Navigation Projects”, dated July 1, 2009;
3. EM 1110-1-1005, “Engineering and Design – Control and Topographic Surveying”, Appendix B-6. Implementation Actions, dated January 1, 2007; and
4. EM 1110-2-6056, “Standards and Procedures for Referencing Project Evaluation Grades to Nationwide Vertical Datums”, dated December 31, 2010.

### *1.8 Previously Authorized Project Cost Information*

Table 4 provides a comparison of 1) the estimated cost for the project as authorized by Congress; 2) the project last presented to Congress in which barge lanes were authorized for construction under the HSC portion of the project; 3) the authorized project updated to FY 17 price level. These last costs were developed by price leveling the costs from the certified Total Project Cost Summary (TPCS), dated 23 August 2016 (see Appendix C) to FY 17 price levels.

The \$13,395,000 shown under the “Galveston Channel - Navigation” portion of Table 4 is the estimated cost (less associated costs) of the Recommended Plan identified later in this report.

The most current cost estimate dated 1 October 2016, for GHCE estimates the Constant Dollar Cost (does not include inflation) at FY 17 price levels as \$15,333,000 (Table 4). For the purpose of calculating the Section 902 limit once the project is authorized, the total estimated project first cost is \$13,395,000, FY 17 price level, including an estimated Federal share of \$10,046,250 and an estimated non-Federal share of \$3,348,750.

**Table 4: Total Project First Costs**

Total Project Cost Summary - FY 17 Price Level			
Construction Item	Total Costs	Federal	Non-Federal
Channel Dredging	\$11,490,000		
41'-46'   75/25		\$8,617,500	\$2,872,500
Berthing Costs (NF)	\$1,938,000		\$1,938,000
PED (75/25)	\$1,504,000	\$1,128,000	\$376,000
Construction Estimate Totals	\$401,000	\$300,750	\$100,250
Total Project First Costs <sup>1</sup> (includes 24% contingency)	\$13,395,000	\$10,046,250	\$3,348,750
<b>Total</b>	<b>\$15,333,000</b>	<b>\$10,046,250</b>	<b>\$5,286,750</b>

<sup>1</sup>For the purpose of calculating the Section 902 limit, the total estimated first cost of the project at FY 17 price levels (1 October 2016) is: \$13,395,000 including an estimated Federal share of \$10,046,250; and an estimated non-Federal share of \$3,348,750.

## **2.0 PROBLEMS AND OPPORTUNITIES**

### *2.1 Problems*

#### *Insufficient Federal channel depth and transportation cost inefficiencies.*

Larger ships that transit the Galveston Harbor Channel Reach, Station 00+000 to Station 20+000, currently experience transportation delays due to insufficient Federal channel depths. In order to reach port terminals beyond Station 20+000 (Gulf Sulphur Services and Texas International Terminals) larger ships must light-load or cargo must be shipped using smaller vessels. The remaining 2,571 feet of authorized channel in the Galveston Channel Reach is only 41 feet deep, and the local sponsor and facilities at the far end of the Galveston Channel Reach are not able to take full advantage of the 46 feet depth of the remainder of the channel.

The economy of the U.S. has become increasingly dependent on waterborne transportation for a wide range of manufactured goods and raw material. The 41-foot authorized channel serves Piers 39, 40 and 41, which have historically handled general cargo, and two additional docks that handle sulphur and dry bulk commodities (e.g. barite). While container vessels have not historically been light-loaded, deep-draft vessels carrying bulk dry commodities that are transiting the 41-foot portion of the Galveston Harbor Channel must arrive and depart light-loaded.

### *2.2 Opportunities*

#### *Reduce transportation costs.*

There is an opportunity to reduce transportation costs for vessels transiting the Galveston Harbor Channel due to the recent addition of portside service facilities utilizing the existing 41-foot channel. This translates to an opportunity to seek the additional authorization needed to extend the limits of the currently authorized 46-foot channel which stops 2,571 feet short of these relatively new facilities.

Deepening the remainder of the channel will allow the facilities at the end of the channel to transport larger volumes of goods with each movement via more fully loaded vessels or deeper draft vessels. This improves productivity by moving cargo more efficiently with less energy expended.

### *2.3 Existing Conditions*

The Galveston Channel intersects at the Inner Bar Channel Station 5+547 and is subdivided into two reaches: Station -8+648.85 to Station 1+700 at Pier 9, and Station 1+700 to Station 13+900, from Pier 9 to 43rd Street. The Extension, Entrance, Outer and Inner Bar Channels have been deepened to their new depths (46 feet) through the previous Houston-Galveston Navigation

Channels, Texas Project. The previously authorized and maintained depth for the area of the Galveston Channel known as the Galveston Channel Reach is 41 feet deep with a width of approximately 1,085 feet. The authorized project template would deepen the channel to 46 feet. The width of the channel would remain the same or smaller than the existing channel, except for the area that intersects with the Houston Ship Channel (HSC). Dredged material from the project is currently disposed of at the San Jacinto and Pelican Island PAs. The Pelican Island PA is located north of the Galveston Channel, approximately 1,100 acres in size and currently divided into three cells. The San Jacinto PA is approximately 500 acres in size and located on the east end of Galveston Island, just north of the Seawall.

#### *2.4 Future Without-Project Condition (FWOP)*

USACE is required to consider the option of "No-Action" as one of the alternatives in order to comply with the requirements of the NEPA. With the No-Action plan, which is synonymous with the "Future Without-Project Condition," it is assumed that no project would be implemented by the Federal Government or by local interests to achieve the planning objectives. The No-Action Plan forms the basis against which all other alternative plans are measured. The future without project condition forms the basis from which alternative plans are formulated and impacts are assessed. Under the future without-project conditions there would be no Federal action to address the navigation concerns. Alternatives are compared to the same without-project condition.

The No-Action Alternative is the continued maintenance of the existing 41 feet deep by 1,085 feet wide channel segment extending a distance of 2,571 feet between Station 20+000 and Station 22+571 (Figure 5). Maintenance dredging of this section is typically performed every four years to maintain project depth. During each four year maintenance cycle approximately 648,000 cubic yards of material are dredged and placed in the existing, designated upland confined Pelican Island PA. Under the No-Action Alternative deeper draft vessels seeking access to the bulk cargo and sulphur facilities at the far west end of the channel would continue to be constrained by channel depth and would continue current non-structural practice of light-loading Panamax vessels to access and depart the bulk cargo facilities. The future without-project condition alternative would retain the 41-foot deep and the 1,085-foot width. The current channel depth and width would continue to limit the efficient movement of commodities by vessels traveling the waterway. The efficiency of the channel would be further burdened by the fact that the adjacent Houston Navigation and Galveston entrance channels are currently dredged to -46 feet. For discussion concerning vessel draft distribution see the economic analysis section on Fleet Characteristics.

## *2.5 Future With-Project Condition*

The future with-project condition includes deepening most of the Galveston Channel, known as the Galveston Channel Reach, to a depth of 46 feet. The alignment of the Galveston Channel as presented in the 2007 LRR and shown in Figure 5 is the recommended plan. There were no significant changes within the project area that warranted a complete reevaluation of potential alternatives or preparation of a new NEPA document; therefore, this report updates project economics and costs of the 2007 recommended plan, and includes limited, required updates of environmental coordination. Details on the original alternatives can be found in the 1995 LRR. No increases in sedimentation are expected as a result of the proposed deepening. Based on this consideration, there is no change to maintenance dredging requirements in the with- versus without project condition.

## **3.0 PLAN FORMULATION**

### *3.1 Federal Objective*

The Federal Objective of water and related land resources project planning is to contribute to national economic development (NED) consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements. NED objectives stress increasing the net values of the national output of goods and services and improving economic efficiency on a national level. The plan that reasonably maximizes net benefits is the NED plan.

Federal objectives are designed to assure systematic interdisciplinary planning, assessment, and evaluation of plans addressing natural, cultural, and environmental concerns, which will be responsive to Federal laws and regulations.

### *3.2 USACE Environmental Operating Principles (EOPs)*

Throughout the study process, EOPs are considered at the same level as economic issues. The seven re-energized EOP principles (July 2012) are:

1. Foster a culture of sustainability throughout the organization;
2. Proactively consider environmental consequences of all USACE activities and act accordingly;
3. Create mutually supporting economic and environmental solutions;
4. Continue to meet our corporate responsibility and accountability under the law for activities undertaken by the USACE which may impact human and natural environments;
5. Consider the environment in employing a risk management and systems approach throughout life cycles of projects and programs;
6. Leverage scientific, economic, and social knowledge to understand the environmental context and effects of USACE actions in a collaborative manner; and
7. Employ an open, transparent process that respects views of individuals and groups interested in USACE activities.

### *3.3 Planning Objectives*

The planning objectives and constraints reflect the reasons for conducting the planning effort. The objectives provide the result that is desired from a project while the constraints tell us what to avoid during the formulation of our plans. The following planning objectives were used in formulation and evaluation of alternative plans:

- Increase deep-draft navigation efficiency for Galveston Harbor Channel over the 50-year

period of analysis;

- Develop an alternative that is environmentally sustainable for the 50-year period of analysis; and
- Reduce navigation transportation costs to and from Galveston Harbor Channel to the extent possible over the 50-year period of analysis.

### *3.4 Planning Constraints*

Unlike planning objectives which represent the desired positive changes, planning constraints represent restrictions that should not be violated. The following constraints apply to this Feasibility Study:

- The study process and plans must comply with Federal and State laws and policies;
- Fish and wildlife habitat affected by a project should be minimized as much as possible and preserved, if possible; and
- Alternative plans that resolve problems in one area should not create or amplify problems in other areas.
- Project depths in excess of 46 feet at Galveston Harbor Channel would not provide additional navigation efficiency benefits vessels are constrained by the adjacent 46-foot authorized channel to reach the study area.

### *3.5 Plan Formulation Process*

During discussions with the Vertical Team (VT), USACE Headquarters (HQ) and Southwestern Division (SWD), in May 2016 on the appropriate path forward for expediting completion of this Feasibility study the team agreed to convert the prior 2013 study Post-Authorization Change Report (PACR) to a Feasibility Report under the Legacy path rather than SMART planning process. No reformulation would be required as the scope of the recommended plan remains the same, deepening the remaining 2,571 feet of the GHCE to 46 feet. The major updates required to finalize this feasibility report are updating the economics, costs, and NEPA coordination.

The planning process for this study has been primarily driven by the overall objective of reviewing and updating the 2013 PACR which analyzed various channel deepening configuration to identify the NED plan. The NED plan included a recommendation to deepening the remainder of the GHCE to match the existing 46-foot depth, allowing for end users to accrue cost savings and benefits while ensuring safe ship traffic along the Galveston Harbor and Channel and protecting the Nation's environmental resources. Prior studies were reviewed to identify areas of data collection needed to move forward with reevaluating the study. Additional alternatives from the 1995 LRR were not developed. This study and subsequent studies were a reevaluation of an existing authorized plan with the primary purpose of updating the project economics and costs. Alternatives developed

during the 1995 LRR study were vetted through the USACE Engineering Research and Development Center (ERDC) ship simulation laboratory. The ship simulation defined the minimum design width required; therefore, no widening alternatives were considered. The terminal end of the GHC functions as a turning basin as it encompasses the entire width and length of the channel which is 1,075 feet wide by approximately 4,700 feet in length. Vessels require this area due to the strong currents within the GHC in order to maintain steerage. The width of the channel in the extension matches this 1,075 feet width. As such, measures for widening and turning basins were not considered for the extension as the ship simulation already verified the width as adequate.

The planning objectives and constraints form the basis for subsequent plan formulation, alternative screening and the identification of the Recommended Plan. The expected FWOP Condition (synonymous to the “No-Action Plan”) was developed for comparison with other alternatives. Additionally, structural and non-structural alternatives were developed. For the structural plans, a variety of channel depths with dredged material placement alternatives were developed, evaluated and screened.

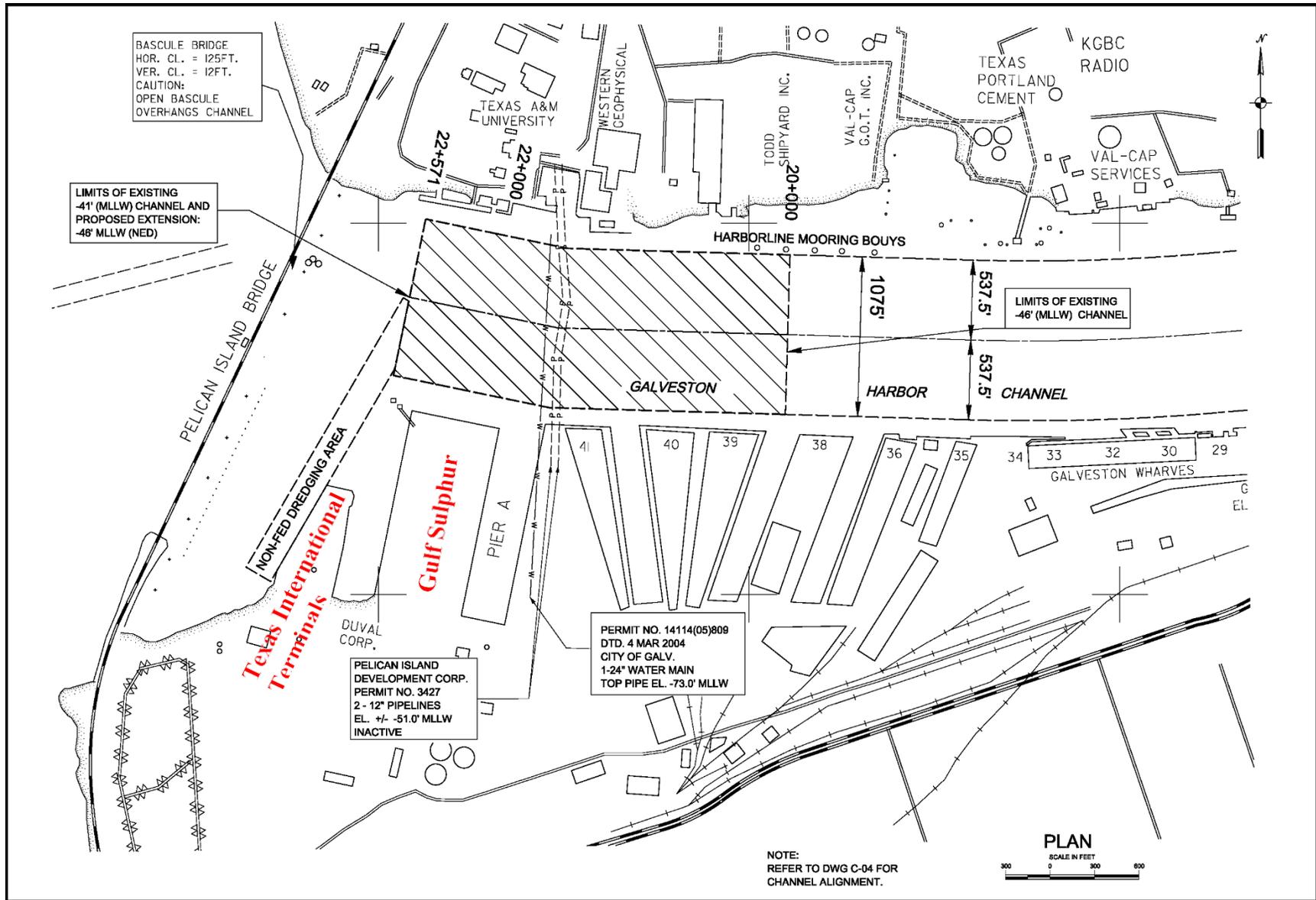


Figure 5 – Location of Proposed Extension within Galveston Harbor Channel

### 3.6 Structural Alternatives

The following Structural Alternatives were considered:

1. 43 feet Deep Channel;
2. 44 feet Deep Channel;
3. 45 feet Deep Channel; and
4. 46 feet Deep Channel.

Net benefits are still rising at 46 feet; however, as addressed under the Section 3.4 Planning Constraints, project depths in excess of 46 feet would not provide additional navigation efficiency benefits as vessels must traverse the adjacent 46-foot authorized channel to reach the study area. Therefore, depths below 46 feet have not been considered for the extension.

Ship simulation performed for the 1995 LRR study validated the required dimensions for the design vessels safe maneuverability for the entire Galveston Harbor Channel. The recommendation for this specific reach of the Galveston Harbor Channel was constructed for the 46-foot depth project. The ship simulation defined the minimum design width required; therefore, no widening alternatives were considered. No lengthening was considered as the channel terminates at the end of the 3.6 mile Galveston Harbor Channel.

The width of the channel in the extension matches this 1,075 feet width. As such, measures for widening and turning basins were evaluated using ship simulation; which provided the with-project footprint.

Construction of the 43, 44, 45, and 46-foot channel alternatives would involve dredging the bottom width of the existing channel only. The existing channel width in the extension is 1,085 feet whereas the new bottom width will be 1,075 feet as shown on Figure 7 in Section 5.1 Project Description. New work materials identified in the Engineering Appendix, Section 6.2.1, consist primarily of stiff to hard high-plasticity clays. Project design elements (e.g., channel width, side slopes, advanced maintenance and allowable over-depth), annual maintenance quantities and impacts for all channel deepening alternatives being considered are essentially the same, but the initial new work dredged quantities generated from the construction of each of alternative would vary. Table 5 presents estimated channel construction new work quantities for each alternative considered.

**Table 5: Initial Dredged Quantities for Channel Alternatives**

<b>Channel Alternative</b>	<b>Total Estimated <sup>1</sup>New Work Volume (cubic yards)</b>	<b>New Work Federal Channel Dredge Volume (cubic yards)</b>	<b><sup>2</sup>Third-Party Facilities (cubic yards)</b>
43 feet Deep Channel Project	255,100	200,400	54,700
44 feet Deep Channel Project	373,233	304,867	68,367
45 feet Deep Channel Project	491,367	409,333	82,033
46 feet Deep Channel Project	609,500	513,800	95,700

<sup>1</sup>New work volume includes quantities for advance maintenance and allowable overdepth.

<sup>2</sup>The Third-Party Facilities dredged volume is not dredged from the Federal Channel; it is dredging of the Third-Party berth. This is necessary for the Third-Party Facility to benefit from the deepening of the Federal Channel to 46 feet. This work is considered an associated cost used in the BCR and is also considered in the placement area capacity analysis.

For all channel project alternatives considered, deepening of the channel and future maintenance would be performed using a hydraulic pipeline dredge with channel dimensions matching the new 46-foot project authorized by WRDA 1996. Shoaling rates at the project location were determined to be stable (the same as the FWOP) and not impacted by the proposed channel depths, based upon a long history of maintenance dredging at the site and engineering analysis. Estimated maintenance dredging for each of the proposed channel alternatives would remain at 648,000 cubic yards per dredging cycle (every four years), representing no increase over current maintenance dredging quantities for the existing 41-foot channel.

### 3.8. Dredged Material Placement Alternatives

Several dredged material placement alternatives were considered, including the existing upland confined PA (i.e., Pelican Island PA), a new upland confined PA on Pelican Island, and a new beneficial use site (marsh) located off the west end of Pelican Island (Figure 6). The Engineering Appendix includes more detailed information on the following placement options, including existing soils data and foundation conditions.

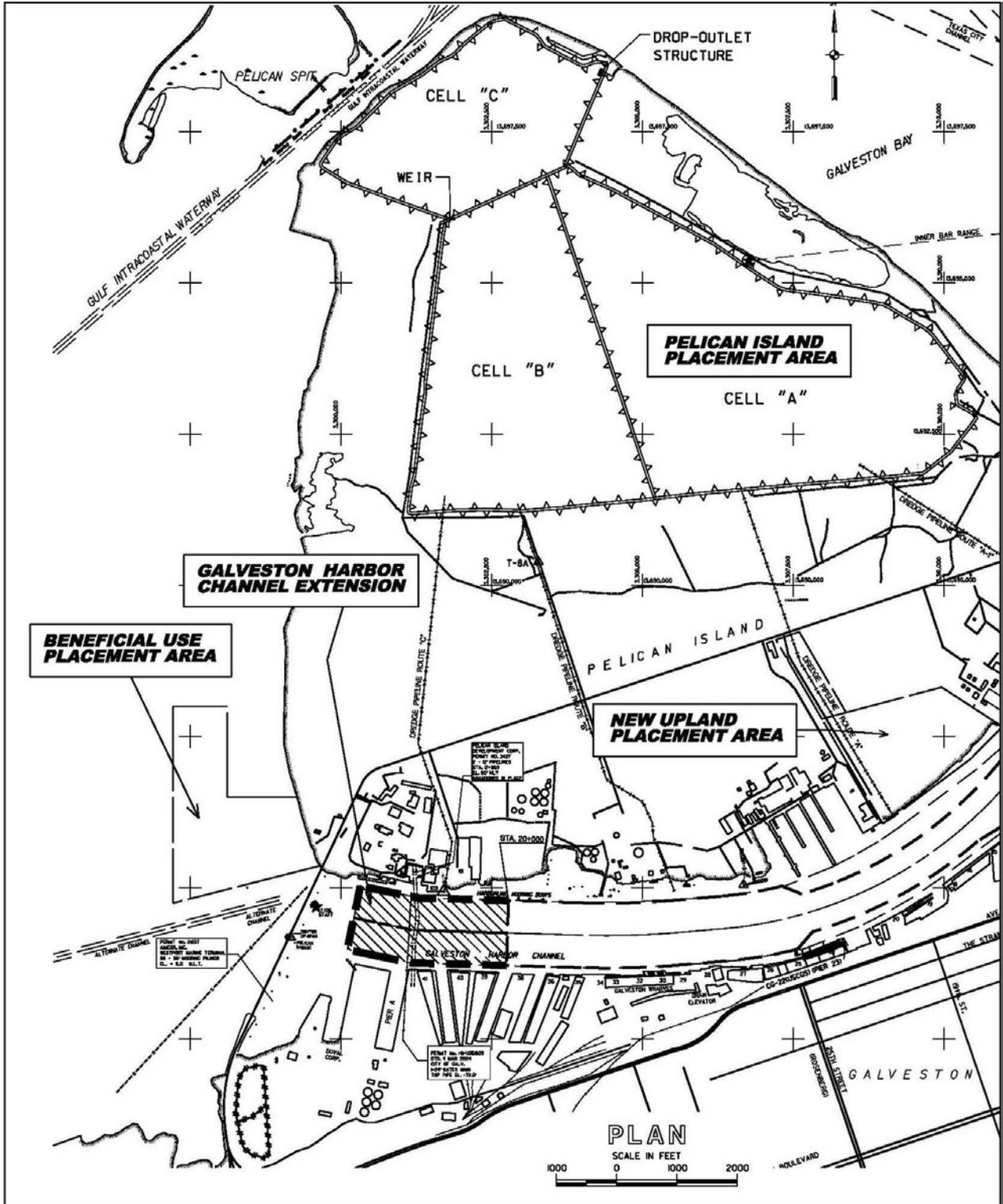


Figure 6 – Dredged Material Placement Alternatives Considered

Beneficial use was considered during plan formulation and discussed in the EA; however, marsh creation was not selected as part of the NED plan. The construction process and design for marsh creation is similar regardless of the beneficial use quantity and corresponding marsh size. Marsh creation would entail mechanically constructing a perimeter dike at an elevation of +5 feet, assuming the average elevation of bay bottom along the west side of Pelican Island is around -5 feet. It was assumed that about 4 feet of the existing bay bottom material is soft and would be removed and replaced with suitable materials. The perimeter dike would be constructed by hydraulic fill methods using new work from the channel deepening. The perimeter dike would be armored using a combination of geotextile, blanket stone, and riprap.

The new work material from the construction of the channel deepening project would be pumped into the marsh site, and amphibious equipment would be used to guide the dredge discharge for fairly even placement across the site. As a follow up measure, five feet deep circulation channels would be constructed inside the marsh cell. Excavated material from construction of the circulation channels would be placed in the eastern area of marsh near the Pelican Island shoreline. Outlet structures would also be put into place. More detailed information on the Beneficial Use Alternative is available in Section 6.3 Beneficial Use Site Alternatives in the Engineering Appendix. Conceptual Drawing B-02, showing the beneficial use alternative, is also available in that appendix.

### *3.9 Non-Structural Alternatives*

Light-loading vessels to accommodate larger vessels under the existing depths was identified as a non-structural alternative. Light-loading is already in use under the without-project condition and therefore was eliminated from the study as it does not provide transportation cost savings. Each alternative also assumes some amount of light-loading continues to occur.

## **4.0 EVALUATION OF CHANNEL AND PLACEMENT ALTERNATIVES**

### *4.1 Screening of Alternatives*

The alternatives were evaluated on their ability to meet the planning objectives to;

- Increase deep-draft navigation efficiency for Galveston Harbor Channel over the 50-year period of analysis;
- Develop an alternative that is environmentally sustainable for the 50-year period of analysis; and
- Reduce navigation transportation costs to and from Galveston Harbor Channel to the extent possible over the 50-year period of analysis.

Each alternative was evaluated with respect to the aforementioned criteria (Table 6).

**Table 6: Alternatives Screening Matrix**

Channel Alternative <sup>1</sup>	Screening Criteria	Increase deep-draft navigation efficiency	Be environmentally acceptable	Maximize Net Benefits
No-Action Alternative (41 feet Deep Channel)			✓	
43 feet Deep Channel Alternative		✓	✓	
44 feet Deep Channel Alternative		✓	✓	
45 feet Deep Channel Alternative		✓	✓	
46 feet Deep Channel Alternative (Recommended Plan)		✓	✓	✓

<sup>1</sup>The channel width for all alternatives, not including the No-Action Alternative, is 1,075 feet. The No-Action Alternative maintains the existing authorized width of 1,085 feet associated with the currently authorized -41 feet MLLW depth of this channel segment.

The No-Action Alternative is considered environmentally acceptable since it would continue to involve only minor temporary impacts to bay bottom experienced during routine maintenance activities. However, deeper draft vessels attempting ingress and egress to the bulk cargo facilities at the far west end of the channel would continue to be constrained by existing channel depth, and would continue current practices of light-loading to access and depart the bulk cargo facilities.

#### 4.2 Increasing Navigation Efficiency

Navigation efficiency is based upon transportation cost savings which produces economic benefits. As detailed in the economic appendix and summarized in Table 7, each alternative produces transportation cost savings.

**Table 7: Transportation Cost Savings per Ton**

Channel Depth	41 feet	42 feet	43 feet	44 feet	45 feet	46 feet
Cost per Ton	\$33.82	\$30.91	\$29.93	\$29.02	\$28.16	\$27.35
Savings per Ton	--	<b>\$2.91</b>	<b>\$3.89</b>	<b>\$4.81</b>	<b>\$5.67</b>	<b>\$6.47</b>

All proposed channel deepening alternatives increased navigation efficiency since deeper channels allow larger volumes of goods to be transported with each vessel movement, as light-loaded vessels can be more fully loaded or smaller vessels are replaced with larger deeper-drafting vessels. As shown in the bottom line, the savings per ton increases from \$2.91 for a 42-foot channel to \$6.47 for a 46-foot channel (Appendix A – Economic Analysis; Fleet Characteristics).

Costs, including dredging, placement, and Operations and Maintenance (O&M) costs for the 50-year period of analysis were estimated from all of the alternatives and compared to the project benefits.

Table 8 displays a summary of the economic analysis and includes benefit-cost ratios (BCRs) and net excess benefits compared to the cost of the proposed project modifications. Only the 46 feet deep channel alternative would accommodate fully-loaded deep-draft vessels traversing the adjacent 46-foot authorized channel ingress and egress of the Port's bulk and sulphur terminal facilities located at the end of the channel thus maximizing project benefits as shown in Table 8.

**Table 8: Summary of Economic Analysis  
Galveston Harbor Channel Extension BCR @ 2.875%**

<b>Galveston Harbor Channel Extension Summary of Economic Analysis</b>				
<b>Item</b>	<b>43-foot</b>	<b>44-foot</b>	<b>45-foot</b>	<b>46-foot</b>
Project Cost	\$6,828,000	\$9,002,000	\$11,202,000	\$13,395,000
Associated Costs	\$1,108,000	\$1,385,000	\$1,661,000	\$1,938,000
Months to Construct	5	5	5	5
Interest During Construction	\$38,000	\$50,000	\$62,000	\$74,000
NED Investment Cost	\$7,974,000	\$10,437,000	\$12,925,000	\$15,407,000
Average Annual Cost	\$303,000	\$396,000	\$491,000	\$585,000
Average Annual Benefits	\$960,000	\$1,186,000	\$1,398,000	\$1,597,000
Net Excess Benefits	\$657,000	\$790,000	\$908,000	\$1,012,000
Benefit-Cost Ratio @ 2.875%	3.2	3.0	2.9	2.7

### *4.3 Environmental Acceptability*

Impacts resulting from any of the proposed channel deepening alternatives would involve only minor temporary impacts to bay bottom comparable in type and magnitude to those experienced during routine dredging maintenance that occurs under the FWOP to maintain the existing channel template. Therefore, all proposed channel alternatives are considered environmentally acceptable and no mitigation would be required for any of the alternatives.

### *4.4 Identification of the Recommended Plan*

The 46-foot channel is the national economic development (NED) plan; the NED plan reasonably maximizes net benefits (benefits minus costs), meets the planning objectives, and is environmentally acceptable; as such it is the Recommended Plan.

A hydraulic pipeline dredge would be used to minimize turbidity during initial dredging. Initial dredging would temporarily increase water column turbidity during dredging activities for any of the proposed channel deepening alternatives; however, these are considered minor and are comparable in type and magnitude to those experienced during routine maintenance dredging that occurs for the existing channel template. Typical cut depth of maintenance material would be identical to the new work.

The least cost (base plan) for dredged material management is to use the Pelican Island PA. Beneficial use may be further explored as needed during preconstruction, engineering, and design (PED) or in the future using Section 204 of WRDA 1992 or Section 207 as amended by Section 2037 of WRDA 2007. The NFS supports upland placement and does not request beneficial use at this time.

This alternative was evaluated in further detail and refined in Section 5, Selected Plan. In addition, its relationship to the overall HGNC project is described.

## 5.0 SELECTED PLAN

The identification of the Recommended Plan from the various alternatives was based upon economic and environmental factors. The environmental consequences are fully described in Section 4 of the EA. There are no adverse environmental impacts anticipated from deepening the remainder of the GHCE. Impacts resulting from the proposed deepening are considered comparable in type and magnitude to those experienced during routine maintenance of the existing channel.

(1) *NED*. For all project purposes except ecosystem restoration, the alternative plan that reasonably maximizes net economic benefits consistent with protecting the Nation's environment, the NED plan, shall be selected. The ASA (CW) may grant an exception when there are overriding reasons for selecting another plan based upon other Federal, State, local, and international concerns. The Recommended Plan is the NED plan.

(2) *Regional Economic Development (RED)*. The RED account identifies changes in the distribution of regional economic activity. Evaluations of regional effects are to be carried out using nationally consistent projections of income, employment, output, and population (ER 1105-2-100). Construction of the 46-foot channel from Station 20+000 to Station 22+571 would provide the navigable depths to the facilities at the end of the channel and allow these users to benefit from the adjacent 46-foot channel and reduce transportation costs realized through the more efficient loading of vessels on a per trip basis. During project construction, the study area would likely have an increase in construction employment and local purchases of construction materials, although this would be temporary. The primary economic bases of the study area include container ship and barge terminal for handling general cargo, sulphur, and dry bulk commodities. As a result of the Recommended Plan, positive economic effects to the study area would occur.

(3) *Effects on Environmental Quality (EQ)*. The EQ account identifies the nonmonetary effects on significant natural and cultural resources (ER 1105-2-100). Environmental considerations associated with these actions include those related to dredging and disposal of dredged material.

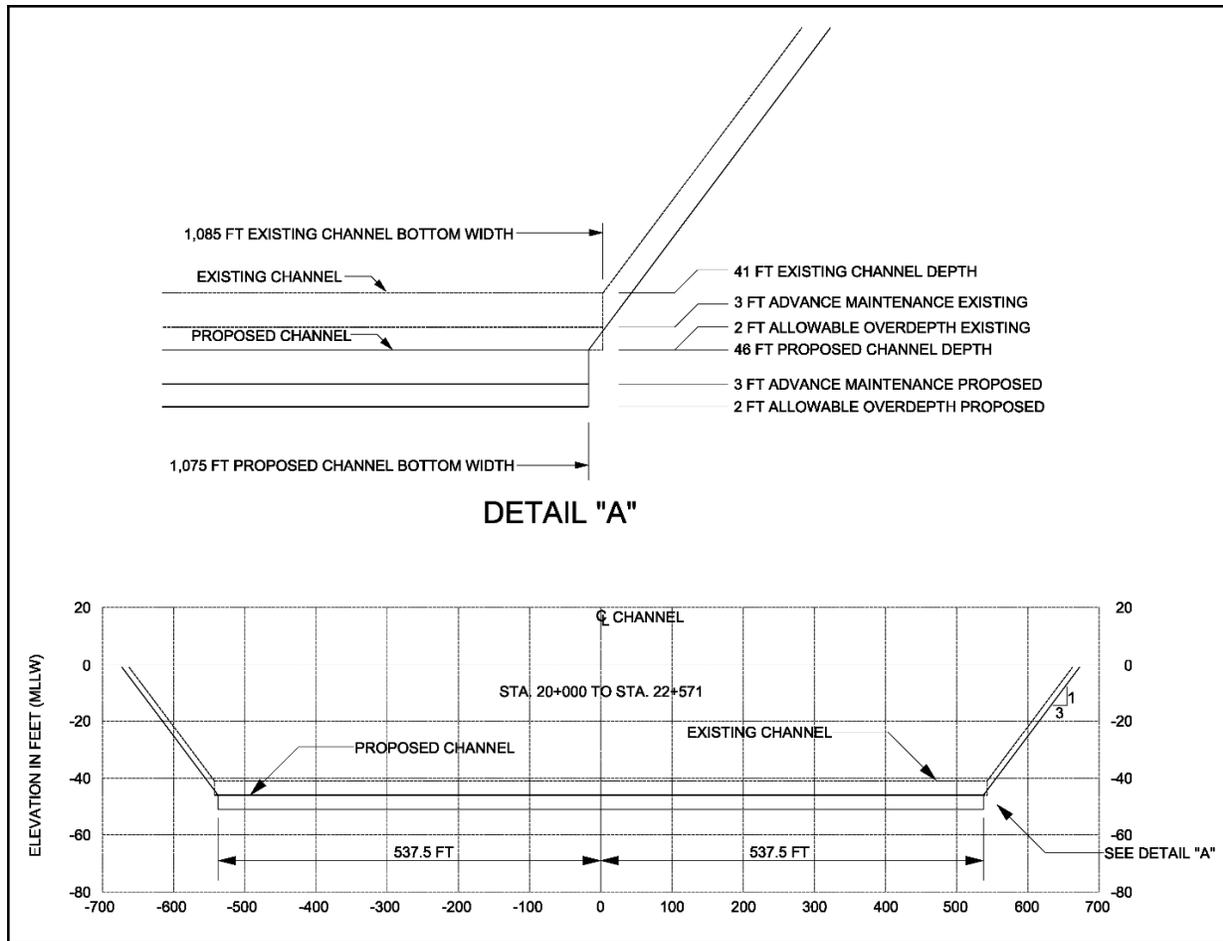
(4) *Other Social Effects (OSE)*. The OSE account identifies the plan effects from perspectives that are relevant to the planning process, but are not reflected in the NED/NER, EQ, and RED accounts (ER 1105-2-100). Structural and nonstructural alternatives must reflect close coordination with interested Federal and State agencies and the affected public. The effects of these measures on the environment must be carefully identified and compared with technical, economic, and social considerations and evaluated in light of public input. The proposed project would not have a disproportionate adverse impact on minority or low-income population groups within the project area.

### *5.1 Project Description*

The proposed channel improvements consist of deepening a segment of the existing 41 feet deep by 1,085 feet wide channel to 46 feet, for a distance of 2,571 feet. The deepening will originate near POG Pier-38 at Station 20+000, continue westward towards Pelican Island Bridge and end at Station 22+571. Station 20+000 demarcates the farthest extent of the authorized 46-foot Galveston Harbor Channel. The project limits for the newly constructed 46-foot Galveston Harbor Channel and the GHCE study area shown previously in Figure 5.

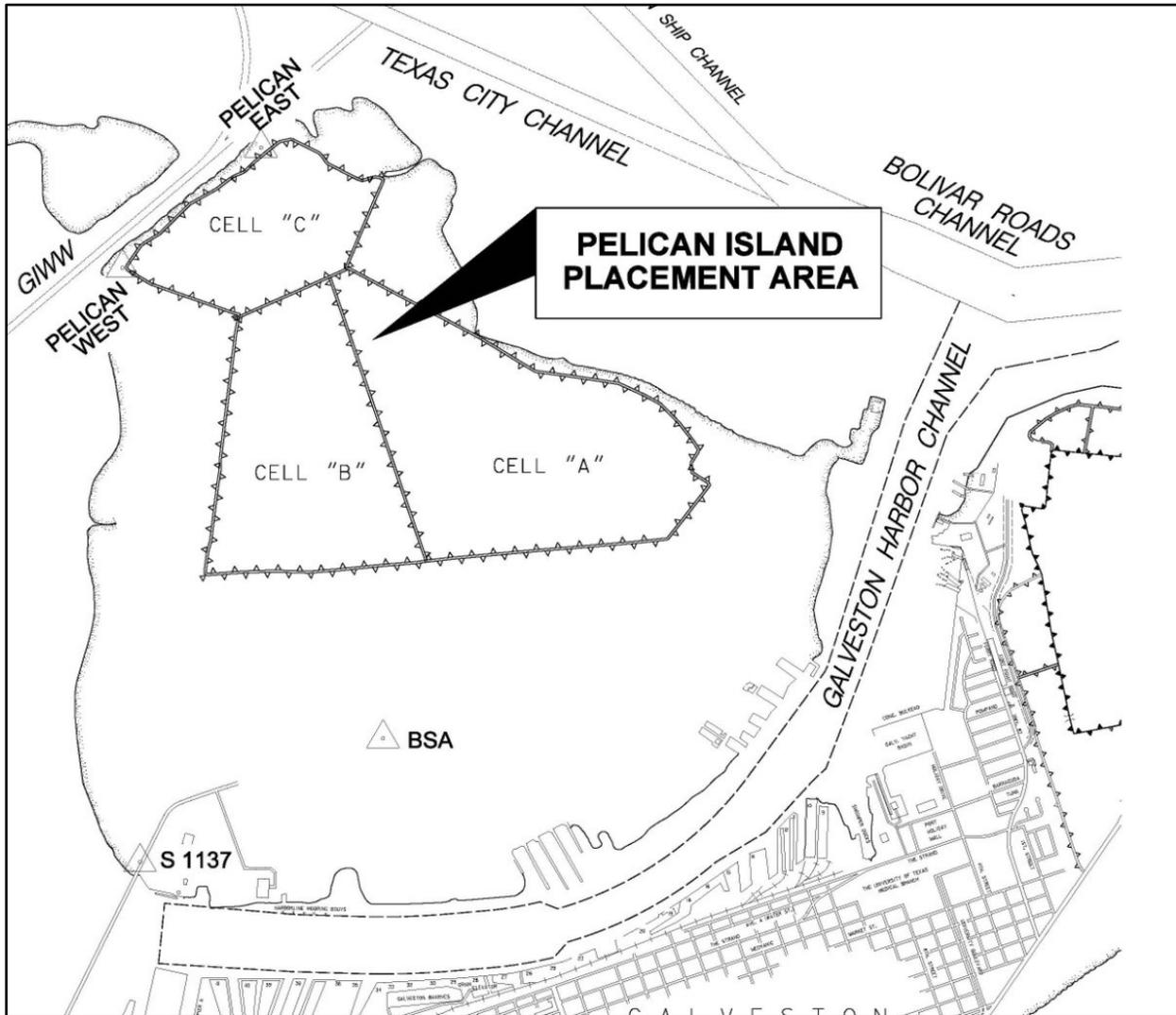
Advanced maintenance and allowable over-depth will remain at the current requirement of 3 feet and 2 feet, respectively, such that the maximum channel depth following periodic maintenance would not exceed 51 feet.

The existing 41-foot channel template that was authorized under the Galveston Harbor and Channel, Texas, project has a bottom width of 1,085 feet. The 46-foot channel bottom width would be 1,075 feet, 10 feet less in width than existing bottom width. Side slopes will be constructed at 1V:3H (1 foot vertical and 3 foot horizontal) as shown in Figure 7. Side slopes will be maintained at 1V:2H.



**Figure 7 – Typical Cross Section of Proposed Extension within Galveston Harbor Channel**

New work materials from channel construction, identified in the Engineering Appendix, Section 6.2.1, would consist primarily of stiff to hard high-plasticity clays. This material would be placed in the upland confined Pelican Island PA (Figure 8), located north of the Galveston Harbor Channel on the northernmost end of Pelican Island. The PA is approximately 1,100 acres in size and is currently divided into a three cell system. For an in-depth description of the Pelican Island PA see Engineering Appendix, Section 6.2.2.



**Figure 8 – Pelican Island PA**

The current estimated dredged material capacity in the Pelican Island PA is 70.9 million cubic yards (MCY) based on an ultimate dike height of + 50 feet and required freeboard of 3 feet, as discussed in the 1995 LRR. The total new work volume anticipated for placement in the PA from construction of the channel extension, 726,900 CY includes 513,800 CY from construction of the extension, 95,700 CY from third-party facilities, plus 102,400 CY of non-pay dredging for the extension and 15,000 CY of non-pay dredging for the third-party facilities. Non-pay dredging would be defined as dredging outside the paid allowable overdepth that may occur due to such factors as unanticipated variations in substrate, incidental removal of submerged obstructions, or unusual wind and wave conditions. See the Engineering Appendix, Section 2.8 for definitions of the various dredging volumes included in the total new work volume.

The maintenance dredging cycle of the channel is defined as the average number of years between the O&M dredging operations for a historical period. Each channel or reach may or may not have its own dredging frequency. The District's Dredging Histories Database, a Microsoft Access-based computer program, was utilized to establish the existing shoaling rate and dredging frequency

for the newly constructed 46-foot Galveston Harbor Channel.

Referencing the 2007 LRR, Engineering Appendix document, an analysis of 24 years of dredging history identified six maintenance dredging cycles with an estimated shoaling rate of 1,425,500 cubic yards per year for the complete 22,571-foot long channel. The newly constructed 46-foot deep channel shoaling rate will be assumed to remain the same as the existing channel; therefore, a linear interpolation of the channel dredging data produces a shoaling rate of approximately 162,000 cubic yards per year for the proposed extension. The maintenance dredging frequency will remain the same (four years) as the existing 46-foot channel (Engineering Appendix, Section 2.6).

About 7.8 MCY of maintenance material (12 maintenance cycles) is forecast for the project (Station 20+000 to Station 22+571) over the 50-year period of analysis, the same as is required for the existing 41-foot channel. All maintenance material would be placed in the existing upland confined Pelican Island PA, consistent with current practices. However, the PA must have capacity for storage of maintenance dredging volumes from the entire GHC (Station 0+000 to Station 22+571) which totals about 68.4 MCY over the 50-year period of analysis. Including the projected new work volume (726,900 cubic yards), the total forecast dredging volume for the 50-year period of analysis is about 69.2 MCY, leaving about 1.7 MCY of available capacity.

No increment of maintenance volumes over and above the historic dredging volumes is anticipated as a result of deepening the channel to 46 feet; therefore, Pelican Island PA has more than sufficient remaining capacity to accommodate the new work volume generated by this project. Based on analysis of the Pelican Island PA capacity, there is no requirement for additional placement areas to contain the new work or maintenance dredge materials over the 50-year period of analysis.

According to the 1995 LRR, previous estimates made near or prior to 1995 indicate that the make-up of dredged maintenance material from the channel has consisted in the past of approximately 80 percent fine grained materials and approximately 20 percent coarse grained or sandy materials (Engineering Appendix, Section 6.2.1).

A hydraulic pipeline dredge would be used to minimize turbidity during initial dredging. Initial dredging would temporarily increase water column turbidity during dredging activities for any of the proposed channel deepening alternatives; however, these are considered minor and are comparable in type and magnitude to those experienced during routine maintenance dredging that occurs for the existing channel template. Typical cut depth of maintenance material would be identical to the new work. For O&M dredging, standard operating procedures employ a pipeline dredge.

The extension would continue to allow the same advanced maintenance and allowable over-depth after it is deepened (Appendix B - Engineering Appendix).

Past NEPA documentation and coordination for the adjacent 46-foot channel identified impacts to bay bottom (benthic habitat) as minor and temporary and required no mitigation. Deepening the extension involves deepening only 2,571 linear feet of channel to match the bottom depth of the recently constructed 46-foot channel. Environmental impacts were analyzed for deepening the GHC and no significant or adverse impacts were identified. Policy compliance and agency coordination is documented in the EA.

### *5.2 Design and Construction Considerations*

The GHCE project would involve deepening a portion of the Galveston Harbor Channel that is currently authorized and maintained at 41 feet deep. All dredged material resulting from the deepening would be placed in the existing Pelican Island PA. No additional land acquisition is required for dredged material placement or channel dredging.

The proposed channel center alignment extends westward from Station 20+000 to the end of the existing 41-foot channel at Station 22+571. This portion of channel would be constructed to match the design of the adjacent newly constructed 46-foot channel with channel side slopes at 1V:3H, and bottom width of 1,075 feet.

### *5.3 Total Project First Costs*

The costs from the certified TPCS dated 1 October 2016 (see Appendix C) were updated to FY 17 price levels. The Total Project Cost (October 2016 price levels) for this feasibility report estimates the constant dollar cost of the GHCE Project at \$15,333,000. The fully funded (total project cost) project estimate, including contingencies and escalation, is \$16,305,000. The study expenditures are not included in that figure.

New authorization is required for the GHCE. The project first cost (less associated costs) of \$13,395,000 (1 October 2016 price level) for the approximately half mile long project would serve as the basis for any future 902 limit calculations.

### *5.4 Project Benefits*

The existing HGNC project benefits result from navigation improvements and environmental restoration improvements. Navigation benefits associated with the various deepening and widening alternatives were derived from reductions in vessel transportation costs, reductions in vessel delays,

and reductions in vessel casualties. The proposed deepening of the channel from Station 20+000 to 22+571 will provide navigation improvements to the facilities at the end of the channel by providing the additional depth to allow these users to benefit from the adjacent 46-foot channel described in the 1995 and 2007 LRR and reduce transportation costs realized through the more efficient loading of vessels on a per trip basis. Table 9 shows the Average Annual Benefits for the HGNC 1995 LRR and the recommended project.

**Table 9: Average Annual Benefits**

HGNC 1995 LRR Average Annual Benefits (October 1994 prices, 7.75% interest),	Galveston Harbor Channel Extension Average Annual Benefits (October 2016 prices, 2.875% interest)
\$87,232,000	\$1,597,000

There will be some slight overall increase in the cost of the project due to the one time construction cost of deepening the extension; however, overall there is expected to be a positive change in project benefits with the deepening of the extension.

*5.5 Benefit-Cost Ratio*

The BCR for the GHCE project and the recommended project is shown in Table 10.

HGNC 1995 LRR  (October 1994 prices, 7.75% interest)	HGNC - Galveston Channel Project  2007 LRR; updated economics on Galveston Portion  (October 2006 prices, 4.875% interest)	Galveston Harbor Channel Extension Feasibility          (October 2016 prices, 2.875% interest)
BCR: 2.3	BCR: 2.3	BCR: 2.7

The 2007 LRR updated economics for the Galveston Channel Project portion of the HGNC and showed a BCR of 2.3 using October 2006 prices and 4.875 percent interest.

The BCR for the Recommended Plan is 2.7. The benefits for the recommended project were calculated for a 50-year period of analysis using FY 2017 Federal Discount rate of 2.875 percent and the deep-draft vessel operating costs contained in the Economic Guidance Memorandum (EGM 15-04).

### *5.6 Cost Apportionment*

Initial construction for the project deepening from 41 feet to 46 feet would be apportioned 75 percent Federal and 25 percent non-Federal with POG, the Sponsor for the GSC portion of the HGNC. Project First Costs for the recommended project are detailed in Table 11. Upon completion of construction the local sponsor must provide an additional cash contribution equal to 10 percent of GNF costs. The costs may be paid over a period not exceeding 30 years. The sponsor's costs for Land, Easements, Rights-Of-Way, and Removals/Relocations (LERR) are credited against the additional cash contribution. No LERR credits are anticipated since the recommended plan will utilize an existing PA, and if constructed deepen the remaining portion of the channel already in use by the NFS. New aids to navigation are not required for this extension.

**Table 11: Recommended Plan - First Costs Allocation**

*(Price Level October 2016)*

<b>Costs Allocated to 46-foot Depth</b>			
	<b>Total Costs</b>	<b>Federal Share</b>	<b>Non-federal Share</b>
<b>General Navigation Features</b>			
Lands – Federal	0	0	0
Navigation	\$11,490,000		
Channel Dredging (41-46 feet)*		\$8,617,500	\$2,872,500
Planning, Engineering and Design	\$1,504,000	\$1,128,000	\$376,000
Construction Management	\$401,000	\$300,750	\$100,250
<b>Total Project First Costs**</b>	<b>\$13,395,000</b>	<b>\$10,046,250</b>	<b>\$3,348,750</b>
<b>Associated Non-Federal Costs (owner cost)</b>			
Portside Dock	\$1,938,000	\$0	\$1,938,000
<b>With Associated Non-Federal Costs Added</b>	<b>\$15,333,000</b>	<b>\$10,046,250</b>	<b>\$5,286,750</b>

\*WIIN 2016 returns cost share up to 50 feet MLLW to 75/25

\*\*TPCS includes a 24 percent contingency

In reference to cost sharing purposes the recommended plan would be authorized at 46 feet deep and therefore does meet the definition for a deep-draft project as defined by Section 214 (1) of WRDA 86. Section 101(a)(4) of WRDA 86 states that the non-Federal Sponsor "...shall perform or assure performance of all relocations of utilities necessary to carry out the project, except in the case of a project for a deep-draft harbor and in the case of a project constructed by non-Federal interest under Section 204..." neither exception of which apply in this instance.

### *5.7 Recommended Plan Environmental Consequences*

A Final EA has been prepared that addresses the environmental consequences of the recommended plan to the GHCE. Environmental impacts resulting from deepening the 41-foot channel to 46 feet are expected to be negligible because construction will occur within the existing project footprint and an existing PA will be used. For a detailed discussion of the environmental consequences of the recommended plan, please refer to Section 4.0 of the Final EA. Summary points of the environmental consequences discussed in the Final EA are included in the following paragraphs.

The environmental review of the recommended modifications included consideration of impacts from sea level rise and to vegetation, wildlife, aquatic resources including Essential Fish Habitat (EFH), threatened and endangered species, cultural resources, socioeconomic resources, Environmental Justice, Prime and Unique Farmlands, Hazardous, Toxic, and Radioactive Wastes, air, noise, water quality, as well as alternative courses of action and cumulative impacts.

The deepening of GHCE would have negligible impacts to very low quality bay bottom habitat comparable in type and magnitude to those experienced during routine maintenance that occurs for the existing channel template. No special aquatic sites, including wetlands, would be impacted. Therefore, no mitigation would be required for this project. Only minor, temporary increases in turbidity, noise and navigation traffic are anticipated. However, such effects would not be “new”, but would be among the cyclical recurring impacts that occur during maintenance of the channel. All affected resources are expected to recover to pre-project conditions after the work is completed. The proposed project is expected to contribute beneficially to navigation efficiency and is not expected to contribute negative cumulative impacts to the area.

The EA includes a Draft General Conformity Determination. To comply with the Clean Air Act, the General Conformity Determination will be completed during Preconstruction Engineering and Design (PED) when the timing and design of the project is known. The proposed project was found to be compliant with the Endangered Species Act, Clean Water Act, EFH, the Texas Coastal Management Plan (TCMP) and other relevant laws and executive orders as discussed in Section 7.0 of the Final EA.

### *5.10 Public Involvement*

Public comment was conducted during the PACR/EA (10 May 2013 to 10 Jun 2013). No adverse comments were received. Appendix B and E of the 2016 EA contains the coordination record. The GHCE Project is very limited in scope, non-controversial, and affects only a previously deepened and regularly maintained channel. No further public review is planned.

## **6.0 FEDERAL AND NON-FEDERAL RESPONSIBILITIES**

By an agreement dated January 22, 2016, the Government and the NFS agreed to cooperate in the Feasibility Study of the GHCE, Texas. The proposed work is not within the provisions of the existing agreement, thus a new PPA will be necessary. Cost sharing of the \$13,395,000 will be 75/25 from 41 to 46 feet MLLW.

As discussed in Section 5.2 Changes in Local Cooperation Requirements (outlined in ER 1105-2-100, Appendix E, Paragraph E-8b(4)(b)), this navigation improvement would serve multiple properties with different owners.

## 7.0 SUMMARY AND CONCLUSIONS

For the purpose of calculating the Section 902 limit, the total estimated first cost of the project at FY 17 price levels (1 October 2016) is: \$13,395,000 including an estimated Federal share of \$10,046,250; and an estimated non-Federal share of \$3,348,750.

The results of the economic analysis in Appendix A show that it is economically justified to deepen the Galveston Channel to 46 feet through the reach presently authorized to 41 feet. Volume continues to increase at the bulk terminal for minerals used in oil and gas exploration and a significant share of this volume is constrained by the current channel depth.

Construction of the 46-foot channel from Station 20+000 to Station 22+571 would provide the navigable depths to the facilities at the end of the channel and allow these users to benefit from the adjacent 46-foot channel and reduce transportation costs realized through the more efficient loading of vessels on a per trip basis. All basic features of the project remain the same. The addition of the 2,571 feet of deepened channel does not add or delete any project purpose.

The economic cost for construction of the extension is approximately \$15,333,000, to include an estimated \$1,938,000 in associated costs. The navigation improvements have an average annual cost of \$585,000 and average annual benefits of \$1,597,000 and a BCR of 2.7.

These recommendations are made with the provision that Congressional Authorization be obtained and that prior to implementation of the recommended improvements, the Federal Government and the NFS (POG) would enter into a Design Agreement for Preconstruction, Engineering, and Design (PED) and a new PPA prior to construction.

## 8.0 RECOMMENDATIONS

Since this Feasibility Report is for new additional authorization and the newly authorized costs it would serve as the basis for any future 902 calculation.

All of the GNF project costs and associated costs are included in the BCR calculation. Total average annual costs for the project are \$585,000 for construction. There are no additional O&M costs over the existing project. Fully Funded Cost of the project, which includes Project Costs and expected escalation totals, is \$16,305,000.

These recommendations are made with the provision that, prior to implementation of the recommended improvements, the NFS shall enter into binding agreements with the Federal government to comply with the following requirements:

The NFS, prior to implementation, shall agree, through the amendment to the PPA, to perform items of project partnership which may include, if applicable, the following:

- a. Provide 10 percent of the total cost of construction of the general navigation features (GNFs) attributable to dredging to a depth not in excess of 20 feet, plus 25 percent of the total cost of construction of the GNFs attributable to dredging to a depth in excess of 20 feet but not in excess of 46 feet, as further specified below:
  - (1) Provide 25 percent of design costs allocated by the Government to commercial navigation in accordance with the terms of a design agreement entered into prior to commencement of design work for the project.
  - (2) Provide, during construction, any additional funds necessary to make its total contribution for commercial navigation equal to 10 percent of the total cost of construction of the GNFs attributable to dredging to a depth not in excess of 20 feet, plus 25 percent of the total cost of construction of the GNFs attributable to dredging to a depth in excess of 20 feet but not in excess of 46 feet.
- b. Provide all lands, easement, rights-of-way, relocations and disposal (LERRD), including those necessary for the borrowing of material and disposal of dredged or excavated material, and perform or assure the performance of all relocations, including utility relocations, all as determined by the Government to be necessary for the construction or operation and maintenance of the GNFs;

- c. Pay with interest, over a period not to exceed 30 years following completion of the period of construction of the GNFs, an additional amount equal to 10 percent of the total cost of construction of GNFs less the amount of credit afforded by the Government for the value of the LER and relocations, including utility relocations, provided by the NFS for the GNFs. If the amount of credit afforded by the Government for the value of LER, and relocations, including utility relocations, provided by the NFS equals or exceeds 10 percent of the total cost of construction of the GNFs, the NFS shall not be required to make any contribution under this paragraph, nor shall it be entitled to any refund for the value of LER and relocations, including utility relocations, in excess of 10 percent of the total costs of construction of the GNFs;
- d. Provide, operate, and maintain, at no cost to the Government, the local service facilities in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and State laws and regulations and any specific directions prescribed by the Government;
- e. Give the Government a right to enter, at reasonable times and in a reasonable manner, upon property that the NFS owns or controls for access to the project for the purpose of completing, inspecting, operating, and maintaining the GNFs;
- f. Hold and save the United States free from all damages arising from the construction or operation and maintenance of the project, any betterments, and the local service facilities, except for damages due to the fault or negligence of the United States or its contractors;
- g. Keep and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of 3 years after completion of the accounting for which such books, records, documents, and other evidence is required, to the extent and in such detail as will properly reflect total cost of construction of the project, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and local governments at 32 C.F.R., Section 33.20;

Perform, or ensure performance of, any investigations for hazardous substances as are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. 9601–9675, that may exist in, on, or under LERRD that the Government determines to be necessary for the construction or operation and maintenance of the GNFs. However, for lands, easements, or rights-of-way that the Government determines to be subject to the navigation servitude, only the Government

shall perform such investigations unless the Government provides the NFS with prior specific written direction, in which case the NFS shall perform such investigations in accordance with such written direction;

- h. Assume complete financial responsibility, as between the Government and the NFS, for all necessary cleanup and response costs of any hazardous substances regulated under CERCLA that are located in, on, or under LERRD that the Government determines to be necessary for the construction or operation and maintenance of the project;
- i. To the maximum extent practicable, perform its obligations in a manner that will not cause liability to arise under CERCLA;
- j. Comply with Section 221 of P.L. 91-611, Flood Control Act of 1970, as amended, (42 U.S.C. 1962d-5b) and Section 101(e) of the WRDA 86, Public Law 99-662, as amended, (33 U.S.C. 2211(e)) which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until the Sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element;
- k. Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, P.L. 91-646, as amended, (42 U.S.C. 4601-4655) and the Uniform Regulations contained in 49 C.F.R. 24, in acquiring lands, easements, and rights-of-way necessary for construction, operation, and maintenance of the project including those necessary for relocations, the borrowing of material, or the disposal of dredged or excavated material; and inform all affected persons of applicable benefits, policies, and procedures in connection with said act;
- l. Comply with all applicable Federal and State laws and regulations, including, but not limited to: Section 601 of the Civil Rights Act of 1964, P.L. 88-352 (42 U.S.C. 2000d), and Department of Defense Directive 5500.11 issued pursuant thereto; Army Regulation 600-7, entitled "*Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army*"; and all applicable Federal labor standards requirements including, but not limited to, 40 U.S.C. 3141-3148 and 40 U.S.C. 3701-3708 (revising, codifying and enacting without substantive change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a et seq.), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 et seq.), and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c));

- m. Provide the non-Federal share of that portion of the costs of mitigation and data recovery activities associated with historic preservation that are in excess of one percent of the total amount authorized to be appropriated for the project; and
- n. Not use funds from other Federal programs, including any non-Federal contribution required as a matching share therefore, to meet any of the NFS's obligations for the project costs unless the Federal agency providing the Federal portion of such funds verifies in writing that such funds are authorized to be used to carry out the project.

Construction of the recommended channel improvements is estimated to take four months to complete. During this period, the Government and the NFS shall diligently maintain the projects at their previously authorized dimensions according to the previous cooperation agreement. Maintenance materials that have accumulated in the channels at the time that "before dredging" profiles are taken for construction payment shall be considered as new work material and cost-shared according to the new cooperation agreement. Any dredging in a construction contract reach after the improvements have been completed and the construction contract closed will be considered to be maintenance material and cost-shared according to the new agreement.

The recommendations contained herein reflect the information available at this time and current Departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels with the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to the Congress as proposals for authorizations and implementation funding. However, prior to transmittal to the Congress, the NFS, the State, interested Federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

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Date

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Lars N. Zetterstrom  
Colonel, Corps of Engineers  
District Engineer

## **9.0 REFERENCES**

USACE 2014. Navigation Projects Compliance with Vertical Datum Guidance. Memorandum from HQUSACE.

\_\_\_\_\_. 2007. Houston-Galveston Navigation Channels, Texas, Galveston Channel Project, Final Limited Reevaluation Report.

\_\_\_\_\_. 1995. The Houston-Galveston Navigation Channels, Texas, Limited Reevaluation Report and Final Supplemental Environmental Impact Statement.

\_\_\_\_\_. 1987. Final Feasibility Report and Environmental Impact Statement, Galveston Bay Area Navigation Study. Volume I, Main Report. U.S. Army Corps of Engineers, Galveston District, Galveston, Texas.

Water Resources Reform and Development Act 2014 (Public Law 113-121), Section 2102(b), dated 10 June 2014.