US Army Corps of Engineers
Galveston District

VOLUME I

FINAL

FREEPORT HARBOR, TEXAS

CHANNEL IMPROVEMENT PROJECT

FEASIBILITY REPORT

September 2012

Volume I Contents for Feasibility Report

1.0 INTRODUCTION
2.0 PROBLEM IDENTIFICATION
3.0 FORMULATION OBJECTIVES, CONSTRAINTS, AND CRITERIA
4.0 PLAN FORMULATION
5.0 PLAN ASSESSMENT AND SCREENING OF INITIAL ALTERNATIVE PLANS
6.0 INITIAL ECONOMIC EVALUATION
7.0 DETAILED PLAN FORMULATION
8.0 ENGINEERING STUDIES
9.0 DETAILED ECONOMIC ANALYSIS
10.0 ENVIRONMENTAL EVALUATION OF THE RECOMMENDED PLAN AND PROPOSED MITIGATION
11.0 50-YEAR DREDGED MATERIAL MANAGEMENT PLAN EVALUATION AND SELECTION
12.0 PLAN SELECTION, RECOMMENDED PLAN, AND PLAN IMPLEMENTATION
13.0 SUMMARY OF COORDINATION, PUBLIC VIEWS, AND COMMENTS
14.0 RECOMMENDATIONS
15.0 REFERENCES

Volume II Contents for Feasibility Report

Appendices:

A Economic Appendix
B Engineering Appendix
C Real Estate Plan
D Baseline Cost Estimate

Contents

Page

List of Figures ... xi
List of Tables ... xii
Executive Summary ... xv
Acronyms and Abbreviations ... xxiii

1.0 INTRODUCTION ... 1-1

- 1.1 PURPOSE AND AUTHORITY ... 1-3
- 1.2 DESCRIPTION OF THE FREEPORT AREA ... 1-3
- 1.3 STUDY AREA DESCRIPTION: THE GENERAL FREEPORT AREA ENVIRONMENTAL SETTING ... 1-4
  - 1.3.1 Air Quality ... 1-5
  - 1.3.2 Fish and Wildlife Resources ... 1-6
  - 1.3.3 Threatened, Endangered, and Protected Species ... 1-7
  - 1.3.4 Cultural Resources ... 1-7
  - 1.3.5 Socioeconomic Considerations ... 1-7
- 1.4 PROJECT AREA DESCRIPTION ... 1-8
- 1.5 ENVIRONMENTAL SETTING ... 1-9
  - 1.5.1 Fish and Wildlife Resources ... 1-13
  - 1.5.2 Threatened and Endangered Species ... 1-14
  - 1.5.3 Water and Sediment Quality ... 1-14
  - 1.5.4 Noise ... 1-14
  - 1.5.5 Hazardous, Toxic, and Radioactive Waste ... 1-15
  - 1.5.6 Prime and Unique Farmland ... 1-15
  - 1.5.7 Cultural Resources ... 1-16
- 1.6 NON-FEDERAL SPONSOR AND COORDINATION ... 1-16
  - 1.6.1 Federal Agencies ... 1-16
  - 1.6.2 State Agencies ... 1-17
  - 1.6.3 Regional, County, and Local Agencies ... 1-17
  - 1.6.4 Other Interests ... 1-17
- 1.7 PRIOR AUTHORIZATIONS ... 1-17
- 1.8 STUDY AND REPORT PROCESS ... 1-18

2.0 PROBLEM IDENTIFICATION ... 2-1

- 2.1 NAVIGATION AND COMMERCE ... 2-1
  - 2.1.1 Historical Traffic Overview ... 2-1
  - 2.1.2 Crude Petroleum Import Overview ... 2-3
  - 2.1.3 Petroleum and Chemical Product Overview ... 2-5

Page

2.1.4 General and Container Cargo Overview 2-6
2.1.5 Liquefied Natural Gas Overview 2-11
2.1.6 Container Overview 2-12
2.1.6.1 Stauffer Channel Modification..2-12
2.1.6.2 Stauffer Channel Container Cargo 2-12
2.2 SAFETY AND NATIONAL SECURITY 2-13
2.3 ENVIRONMENTAL...2-14
2.4 PROBLEM SUMMARY...2-14

3.0 FORMULATION OBJECTIVES, CONSTRAINTS, AND CRITERIA 3-1
3.1 NATIONAL OBJECTIVES 3-1
3.1.1 Regional Sediment Management 3-2
3.2 PLANNING OBJECTIVES 3-2
3.3 PLANNING CONSTRAINTS 3-2
3.4 PHYSICAL CONSTRAINTS 3-3
3.5 GUIDANCE AND CRITERIA 3-3
3.5.1 Technical Criteria...3-3
3.5.2 Economic Criteria 3-4
3.5.3 Environmental Criteria...3-4
3.5.4 Social and Other Criteria..3-5
3.5.5 Other USACE Initiatives...3-5
3.5.5.1 USACE Campaign Plan..3-5

4.0 PLAN FORMULATION 4-1
4.1 PLAN FORMULATION RATIONALE...4-1
4.2 NO ACTION AND FUTURE WITHOUT-PROJECT CONDITION.....................4-3
4.2.1 FWOP-1 4-7
4.2.2 FWOP-2 4-7
4.3 MANAGEMENT MEASURES...4-7
4.3.1 Nonstructural Measures...4-8
4.3.2 Structural Measures...4-8

5.0 PLAN ASSESSMENT AND SCREENING OF INITIAL ALTERNATIVE PLANS 5-1
5.1 SCREENING PROCESS...5-1
5.2 NAVIGABILITY/WIDTH SCREENING 5-3
5.3 SELECTED ALTERNATIVE PLANS..5-5
5.4 ENVIRONMENTAL CONSIDERATIONS ALTERNATIVES.............................5-6
5.4.1 No Action Plan...5-6

Page

5.4.2 Future Without-Project Plan (FWOP-1) 5-6
5.4.3 Federal Channel Deepening and Widening 5-6

6.0 INITIAL ECONOMIC EVALUATION 6-1
6.1 GENERAL – INITIAL SCREENING OF SELECTED ALTERNATIVES 6-1
6.1.1 Benefit Calculations for Petroleum 6-2
6.1.2 Other Cargo 6-7
6.1.3 Container Cargo/Stauffer Channel Modification 6-8
6.2 FREEPORT HARBOR CHANNEL INITIAL BENEFIT SUMMARY 6-10

7.0 DETAILED PLAN FORMULATION 7-1
7.1 GENERAL 7-1
7.2 PROCESS 7-1

8.0 ENGINEERING STUDIES 8-1
8.1 GENERAL 8-1
8.2 DATUM REQUIREMENTS 8-1
8.2.1 Datum 8-1
8.2.2 Horizontal 8-1
8.2.3 Tidal Datum 8-1
8.2.4 Conversion 8-2
8.3 HYDROLOGY AND HYDRAULICS 8-3
8.3.1 Modeling Studies 8-3
8.3.1.1 Field Data Collection 8-3
8.3.1.2 Hydrodynamic Study 8-3
8.3.1.3 Ship Simulation 8-3
8.3.1.4 Sediment Study 8-4
8.3.1.5 Hurricane-induced Storm Surge Conditions 8-5
8.3.1.6 Shoreline Impact Study 8-5
8.4 GENERAL ENGINEERING 8-5
8.5 STRUCTURAL 8-6
8.6 GEOTECHNICAL STUDIES 8-6
8.6.1 Dredged Materials and Potential for Beneficial Use 8-7
8.6.2 Ocean Dredged Material Disposal Sites 8-8
8.6.3 Jetty Stability Analysis 8-8
8.6.4 Critical Locations and Findings 8-9
8.6.5 Levee and Channel Templates 8-10
8.6.6 Jetty Sand Retention 8-10
8.6.7 Recommended Additional Investigations 8-10
8.6.7.1 Freeport Channel 8-10

Page

8.6.7.2 Upland Placement Areas 8-11
8.6.7.3 New Placement Areas 8 and 9..8-11
8.7 COST ESTIMATES 8-11
8.8 VALUE ENGINEERING...8-12
9.0 DETAILED ECONOMIC ANALYSIS...9-1
9.1 GENERAL...9-1
9.2 EXISTING CHANNEL USE 9-1
9.3 CHANNEL REACHES...9-4
9.4 EXISTING OPERATING CONSTRAINTS...9-5
9.5 HISTORICAL TRAFFIC 9-7
9.5.1 Petroleum and Chemical Products 9-8
9.5.2 General and Container Cargo...9-10
9.5.3 Offshore Supply, Offshore Platform Rigs, and Research and Seismic Traffic...9-10
9.5.4 Liquefied Natural Gas 9-12
9.6 HISTORIC VESSEL UTILIZATION PATTERNS...9-12
9.6.1 Underkeel Clearance 9-13
9.6.2 Commodity-Specific Vessel Utilization...9-13
9.6.2.1 Crude Petroleum Tanker Fleet 9-14
9.6.2.2 Petroleum Product Vessels...9-18
9.6.2.3 Chemical Product Carriers 9-18
9.6.2.4 Bulk Carriers 9-19
9.6.2.5 Container Vessels...9-19
9.6.2.6 Offshore Supply, Seismic, and Research Vessels 9-21
9.6.2.7 Liquefied Natural Gas 9-23
9.6.2.8 Effects of Panama Canal Expansion 9-23
9.7 WITHOUT-PROJECT CONDITION..9-24
9.8 PROJECT ALTERNATIVES 9-26
9.9 TRAFFIC FORECAST 9-26
9.9.1 CRUDE PETROLEUM IMPORTS 9-27
9.9.1.1 Crude Petroleum Imports by Trade Route............................9-31
9.9.2 PETROLEUM PRODUCT IMPORTS 9-33
9.9.2.1 Petroleum Products Imports by Trade Route 9-34
9.9.3 CHEMICAL PRODUCT EXPORTS...9-35
9.9.3.1 Chemical Product Exports by Trade Route..........................9-36
9.9.4 CONTAINER IMPORTS AND EXPORTS 9-38
9.9.4.1 Container Imports And Exports by Trade Route..................9-44

Page

9.9.5 UPPER STAUFFER ... 9-44

9.10 INCREMENTAL ANALYSIS ... 9-46

9.10.1 CHANNEL DEEPENING BENEFITS ... 9-47

9.10.1.1 Crude Petroleum Imports Transportation Savings Benefits ... 9-52

9.10.1.2 Petroleum Product Imports Transportation Savings Benefits ... 9-53

9.10.1.3 Chemical Product Export Transportation Savings Benefits ... 9-55

9.10.2 Container Transportation Savings Benefits ... 9-56

9.10.3 Offshore Supply, Research, and Seismic Vessels Transportation Savings Benefits ... 9-57

9.11 ECONOMIC SUMMARY ... 9-57

9.12 REGIONAL ECONOMIC BENEFITS ... 9-60

9.12.1 Regional Economic Benefits Summary and Conclusions ... 9-67

9.13 SUMMARY AND CONCLUSIONS ... 9-68

10.0 ENVIRONMENTAL EVALUATION OF THE RECOMMENDED PLAN AND PROPOSED MITIGATION ... 10-1

10.1 PHYSIOGRAPHY ... 10-1

10.2 TERRESTRIAL AND WETLAND HABITATS ... 10-1

10.3 CLEAN WATER ACT ... 10-1

10.4 MARINE PROTECTION, RESEARCH, AND SANCTUARIES ACT ... 10-3

10.5 MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT ... 10-3

10.6 COASTAL ZONE MANAGEMENT ACT ... 10-3

10.7 FISH AND WILDLIFE COORDINATION ACT ... 10-3

10.8 MARINE MAMMAL PROTECTION ACT OF 1972 ... 10-3

10.9 COASTAL BARRIER IMPROVEMENT ACT OF 1990 ... 10-4

10.10 FARMLAND PROTECTION POLICY ACT OF 1981 AND THE COUNCIL ON ENVIRONMENTAL QUALITY MEMORANDUM PRIME OR UNIQUE FARMLANDS ... 10-4

10.11 EXECUTIVE ORDER 11988, FLOODPLAIN MANAGEMENT ... 10-4

10.12 EXECUTIVE ORDER 12898, ENVIRONMENTAL JUSTICE ... 10-4

10.13 CLEAN AIR ACT ... 10-4

10.14 NOISE ... 10-5

10.15 HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE ... 10-5

10.16 THREATENED AND ENDANGERED SPECIES ... 10-5

Page

10.17 CULTURAL RESOURCES....................10-5
10.18 CUMULATIVE IMPACTS....................10-6
10.19 PROJECT MITIGATION....................10-6
10.19.1 Habitat Evaluation Procedure....................10-7
10.19.2 Site Description and Selection of Evaluation Species....................10-8
10.19.3 HEP Modeling....................10-9
10.19.3.1 Future Without-Project....................10-9
10.19.3.2 Future With-Project....................10-11
10.20 COST EFFECTIVENESS AND INCREMENTAL COST ANALYSIS....................10-14
10.20.1 Forest Mitigation....................10-14
10.20.1.1 Scales....................10-14
10.20.2 Wetland Mitigation....................10-15
10.20.2.1 Assumptions Using a Medium-density Wetland Planning Scheme....................10-17
10.20.3 IWR-PLAN....................10-17
10.20.4 Cost Effectiveness and Incremental Cost Analysis Summary....................10-20
10.21 MITIGATION MONITORING AND CONTINGENCY PLANS....................10-20
10.21.1 Introduction....................10-20
10.21.2 Success Criteria....................10-21
10.21.3 Riparian Tree Plantings....................10-21
10.21.3.1 Establishment Year....................10-21
10.21.3.2 Postestablishment Monitoring....................10-22
10.21.4 Aquatic Pond Vegetation....................10-23
10.21.4.1 Establishment Year....................10-23
10.22 CORRECTIVE ACTIONS (ADAPTIVE MANAGEMENT)....................10-25
10.22.1 Riparian Tree Plantings....................10-25
10.22.2 Aquatic Plantings....................10-25
10.22.3 Adaptive Management Costs....................10-25
10.22.4 Annual Monitoring Reports....................10-26
10.22.5 Final Close-Out Monitoring Report....................10-27
10.23 MITIGATION MONITORING AND REPORTING COSTS....................10-27

11.0 50-YEAR DREDGED MATERIAL MANAGEMENT PLAN EVALUATION AND SELECTION....................11-1

11.1 DREDGED MATERIAL PLACEMENT PLAN....................11-1
11.2 50-YEAR CAPACITY AND DREDGED MATERIAL MANAGEMENT PLAN....................11-1
11.2.1 Environmental Restrictions Pertaining to Upland and Offshore Dredge Material Placement....................11-1

Page

11.2.1.1 Upland PA Water Quality 11-1
11.2.1.2 Ocean Dredged Material Disposal Site 11-2
11.2.2 Dredge Materials and Potential for Beneficial Use 11-2
11.3 50-YEAR CAPACITY AND DREDGE MATERIAL PLACEMENT DESIGNATION 11-3
11.4 OCEAN DREDGE MATERIAL DISPOSAL SITES..11-3
11.5 UPLAND CONFINED PLACEMENT PLAN 11-6
11.5.1 Existing Placement Area 1 11-6
11.5.2 New Placement Area 8...11-6
11.5.3 New Placement Area 9...11-6
11.5.4 Verification of Placement Area Elevation Data 11-6
11.6 BENEFICIAL USE PLACEMENT PLAN...11-7
11.7 DREDGED MATERIAL MANAGEMENT PLAN..11-7
11.7.1 Outer Bar Channel – Stations –370+00 to 71+52.58................................11-7
11.7.2 Main Channel – Stations 71+52.58 to 184+20...11-7
11.7.3 Stauffer Channel – Stations 184+20 to 256+00..11-7

12.0 PLAN SELECTION, RECOMMENDED PLAN, AND PLAN IMPLEMENTATION...12-1
12.1 OVERVIEW...12-1
12.2 RISK AND UNCERTAINTY 12-1
12.2.1 Uncertainty in Technical Evaluations...12-3
12.2.1.1 Engineering Data and Models 12-3
12.2.1.2 Economic Analysis...12-5
12.3 SENSITIVITY OF PROJECT ALTERNATIVES TO RELATIVE SEA LEVEL RISE 12-5
12.3.1 Projected Relative Sea Level Rise Impacts for the Project Area 12-7
12.4 DESCRIPTION OF RECOMMENDED PLAN 12-9
12.5 GENERAL NAVIGATION FEATURES OF THE RECOMMENDED PLAN 12-9
12.5.1 Outer Bar/Jetty Channel 12-10
12.5.2 Main Channel...12-10
12.5.3 Stauffer Channel...12-10
12.5.4 Lands, Easements, and Rights-of-Way 12-11
12.5.5 Facility Removals/Deep-Draft Utility Relocations.................................12-11
12.5.6 Regional Sediment Management 12-12
12.6 PLAN IMPLEMENTATION..12-12
12.6.1 Division of Plan Responsibilities and Cost-Sharing Requirements.........12-12
12.7 COSTS FOR THE RECOMMENDED PLAN 12-13

Page

12.8 COST-SHARING APPORTIONMENT 12-16
12.9 ADDITIONAL NON-FEDERAL SPONSOR CASH CONTRIBUTION 12-16
12.10 NON-FEDERAL SPONSOR VIEWS 12-17
12.11 RECOMMENDED PLAN AND RECENT USACE INITIATIVES 12-17
12.11.1 USACE Actions for Change as Reflected in the Campaign Plan 12-17

13.0 SUMMARY OF COORDINATION, PUBLIC VIEWS, AND COMMENTS 13-1
13.1 OVERVIEW 13-1
13.2 PUBLIC INVOLVEMENT 13-1

14.0 RECOMMENDATIONS 14-1
14.1 OVERVIEW 14-1
14.2 RECOMMENDATION 14-5

15.0 REFERENCES 15-1

Page

APPENDICES:

A Economic Appendix
B Engineering Appendix
C Real Estate Plan
D Baseline Cost Estimate

FIGURES

		Page
ES-1	Freeport Harbor Study Area	xvi
ES-2	Effective Water Depth, Freeport Harbor Study Area, Mean Low Tide – Mean Lower Low Water	xviii
1	Freeport Harbor Study Area	1-2
2	Freeport Harbor Channel	1-11
3	U.S. and Freeport Crude Petroleum Imports (1970–2009)	2-5
4	Freeport Harbor 1970–2006 Other Ocean-going Cargo	2-8
5	Port Freeport	2-9
6	U.S. LNG Imports 2006–2030	2-11
7	Port Freeport Widening Project	4-5
8	Freeport Harbor General Cargo (Imports and Exports) and Coastwise	6-7
9	Effective Water Depth, Freeport Harbor Channel, Mean Low Tide – Mean Lower Low Water	8-2
10	Freeport Harbor Facilities	9-2
11	U.S. Total Containership Trips, Percentage of Trips by Loaded Draft (2003–2006)	9-21
12	U.S. and Freeport Petroleum Product Imports, 1990–2010	9-33
13	Freeport Chemical Product Exports (1990–2009)	9-36
14	U.S. Total Expenditure Forecast (2006–2039)	9-39
15	U.S. Gross Domestic Product Forecast (2006–2039)	9-40
16	Texas Container Cargo 1990–2020	9-42
17	Placement Areas	10-2

TABLES

		Page
ES-1	Recommended Plan Cost, Comparison of Costs, October 11	xx
ES-2	Cost Apportionment	xxi
1	Authorized Freeport Harbor Dimensions	1-9
2	Freeport Harbor Deep-Draft Tonnage, 1970–2009	2-2
3	Comparison of Freeport and Regional and National Totals, Crude Petroleum Imports	2-4
4	Freeport Harbor Petroleum and Chemical Product Imports and Exports, Freeport Percentages of U.S. Totals	2-6
5	Freeport Harbor Other Ocean-going Cargo Major Commodities, 1970–2007	2-7
6	Initial Costs and Benefits for Considered Alternatives	4-2
7	Initial Screening of Project Management Measures	5-2
8	Tanker Characteristics and Hourly Operating Cost, Foreign Flag Double-Hull Tankers	6-3
9	Freeport Harbor Crude Petroleum Tankers, 2001 and 2003	6-3
10	Crude Petroleum Imports, 2001–2003 Average	6-4
11	Representative Round-Trip Mileage to Freeport Harbor	6-5
12	Freeport Harbor Crude Oil Import Tonnage by Trade Route	6-5
13	Transportation Savings by Channel Depth and Commodity Group	6-6
14	Economic Summary	6-6
15	Freeport Harbor General Cargo Deep-Draft Commodities Other Than Petroleum and Chemical Foreign Imports and Exports	6-7
16	Representative Gulf Coast Channel Containerships (2003)	6-9
17	Jetty Stability Analysis – Summary of Calculated Minimum Factors of Safety	8-10
18	Brazos Pilots Association Guidelines Boarding Instructions	9-6
19	Freeport Harbor 2006 Imports and Exports by Region (all Foreign Imports and Exports), Estimated Distribution of Imports and Exports by Region of Origin	9-8
20	Freeport Harbor Tonnage by Major Commodity Groups (1970–2009)	9-9
21	Freeport Harbor Crude Petroleum Imports by Vessel DWT, 1990–2007	9-14
22	Freeport Harbor Crude Petroleum Representative Tanker Sizes	9-14
23	Freeport Crude Petroleum Imports by Region or Country of Origin, 2000–2009	9-17
24	Freeport Percentage of Crude Oil Imports by Vessel Parcel Size, 1993 and 2007	9-18
25	U.S. Crude Oil Imports Projection Comparison	9-28
26	Regression Equation Data for Freeport Crude Oil Imports	9-29
27	Maximum Loaded Cargo	9-30
28	Number of Shuttle Vessels Needed by Channel Depth Alternative	9-30
29	Freeport Harbor Petroleum Product Trade Route Distribution, 2003–2006 Representative Distribution by Major Trade Route	9-35

Page

30 Port Depths at Major Ports Receiving Chemical Products from Freeport, 2003–2005 9-37
31 Global Insight U.S. Gross Domestic Product Forecast 9-39
32 Houston-Galveston-Brazoria Statistical Metropolitan Area Population Projections Texas Counties Adjacent to Freeport, Texas 9-41
33 Expected Container Fleet Distribution by Vessel DWT (South and Central America Exports) 9-43
34 Containership Vessels by Loaded Draft (Limited Review) 9-45
35 Number of Offshore Rigs, Freeport and Galveston Vicinity 9-46
36 Adjustments for Estimating Actual Vessel Capacity, Short Tons of Cargo as a Percentage of Vessel DWT 9-48
37 Representative Round-trip Mileage to Freeport Harbor 9-48
38 Tanker Characteristics and Hourly Operating Cost, Foreign Flag Double-Hull Tankers 9-49
39 Foreign Flag Container Vessel Operating Costs 9-49
40 Foreign Flag Container Vessel Load Factors (Mediterranean, Asia) 9-50
41 Foreign Flag Container Vessel Load Factors (South and Central America) 9-50
42 Foreign Flag Container Vessel Load Factors (Europe, Africa) 9-51
43 Transportation Cost Calculation (Mexico to Freeport) 9-51
44 Freeport Crude Petroleum Imports Transportation Cost and Savings, Most Likely Transportation Mode 9-53
45 Freeport Crude Petroleum Imports, Percentage of Tonnage With Draft Constraints 9-54
46 Freeport Petroleum Product Imports, Percentage of Tonnage With Draft Constraints 9-54
47 Freeport Petroleum Product Imports Benefits 9-55
48 Percentage of Tonnage With Draft Constraints 9-55
49 Freeport Chemical Product Exports Benefits 9-56
50 Freeport Offshore Supply, Research, and Seismic Vessel Benefits 9-57
51 Crude Petroleum for Seaway Terminal and Chemical Products for Dow Chemical (Reach 1), Average Annual Benefits and Costs 9-58
52 Crude Petroleum and Petroleum Products for ConocoPhillips (Reach 2), Average Annual Benefits and Costs 9-59
53 Containers for Velasco Terminal (Reach 3), Average Annual Benefits and Costs 9-59
54 Upper Stauffer (Reach 4), Average Annual Benefits and Costs 9-60
55 Economic Summary of NED and LPP for Freeport Channel and Stauffer Modification, Average Annual Values (4.0% and $1,000) 9-61
56 Economic Summary of NED and LPP for Freeport Channel and Stauffer Modification, Average Annual Values (7.0% and $1,000) 9-62
57 Employment Impact by Sector and Job Category, Number of Jobs 9-65
58 Summary of the Local and Regional Economic Impacts Generated by Port Freeport 9-66

Page

59 Job Impacts per 1,000 Tons 9-67
60 NED and LPP Channel Depth Summary 9-68
61 Average HSI Values and HUs for All Habitats in Project Impact Areas 10-10
62 Future Without-Project AAHUs in Evaluation Species' Habitats 10-11
63 Future With-Project AAHUs in Evaluation Species' Habitats 10-12
64 AAHUs for Forest Species at Proposed Mitigation Sites, FWOP vs. FWP Mitigation 10-16
65 AAHUs for Wetland Species at Proposed Mitigation Sites, FWOP vs. FWP Mitigation 10-18
66 IWR-Plan Analysis, Costs and Outputs for Cost Effective and Best Buy Plans 10-19
67 Incremental Cost of Best Buy Plan Combinations 10-20
68 Adaptive Management Costs 10-26
69 Mitigation Monitoring and Report Costs 10-27
70 Freeport Harbor Channel Improvement Project – Summary of New Work Dredging 11-4
71 Freeport Harbor Channel Improvement Project – Summary of Maintenance Dredging & Placement Area Parameters 11-5
72 Proposed Freeport Channel Dimensions for Recommended Plan 12-11
73 Recommended Plan Cost, Comparison of Costs 12-14
74 Cost Apportionment 12-15
75 Total General Navigation Features Costs and Credits 12-17

EXECUTIVE SUMMARY

The purpose of this feasibility study is to develop and evaluate alternatives for navigation problems that directly affect the Freeport Harbor Channel. To allow for a more effective, safe, and efficient waterway, the study focused on eliminating the major problems contributing to inefficiencies on the waterway, such as insufficient depth and width, as determined by fleet forecasts and the requirement for one-way and daylight-only traffic in the channel. The study evaluated project benefits based on reductions in transportation costs generated from more-efficient loading of the existing fleet, from reductions in vessel delays, and the introduction of larger vessels. The study was conducted to determine whether navigation problems currently being experienced at Freeport Harbor could be alleviated and are in the Federal interest and to provide documentation needed to recommend Congressional authorization and funding for construction of that project. The Freeport Harbor study area is shown on Figure ES-1.

The original project for Federal channel improvement at Freeport was authorized by the River and Harbor Act (RHA), approved June 14, 1880, which provided for construction of jetties for controlling and improving the channel over the bar at the mouth of the Brazos River. Work was started in 1881 and continued to 1886 when operations were suspended due to lack of funds. In March 1899, the Brazos River Channel and Dock Company, under authority granted by the RHA of August 21, 1888, began rework on the navigation channel. The company was unable to finance completion of the work, and in April, the works, rights, and privileges were transferred to the United States. This constituted the initial authorization for the existing project for Freeport Harbor.

The existing Freeport Harbor Project was authorized by the RHAs of May 1950 and July 1958. The acts provided for an Outer Bar Channel 38 feet deep and 300 feet wide from the Gulf of Mexico to a point inside the jetties and for inside channels 36 feet deep and 200 feet wide to and including the Upper Turning Basin. Greater depth and width were authorized by Congress in 1970 (Section 101 of RHA of 1970, PL 91-611; House Document 289, 93rd Congress – 2nd Session, 31 Dec 1975) and by the President in 1974. These authorizations were for the Jetty Channel to be relocated and deepened to 45 feet, widened to 400 feet, and the North Jetty relocated northward. The relocated Entrance Channel (Outer Bar) was authorized to a 400-foot width, to a 47-foot depth, and to extend approximately 4.6 miles into the Gulf of Mexico. A Final Environmental Impact Statement for the project was prepared by the U.S. Army Corps of Engineers (USACE) in 1978. In 1978, Seaway Pipeline, Inc., under a Department of Army permit, was authorized to widen the Entrance (Outer Bar) Channel to 400 feet and the Jetty Channel to 230 feet. Seaway Pipeline was formed as a consortium in the 1970s to construct the Seaway Terminal, storage tankage at the Jones Creek Tank Farm, and the pipeline from Jones Creek Tank Farm to Cushing, Oklahoma, to transport foreign crude into the Heartland. The Outer Bar Channel was widened under the permit.

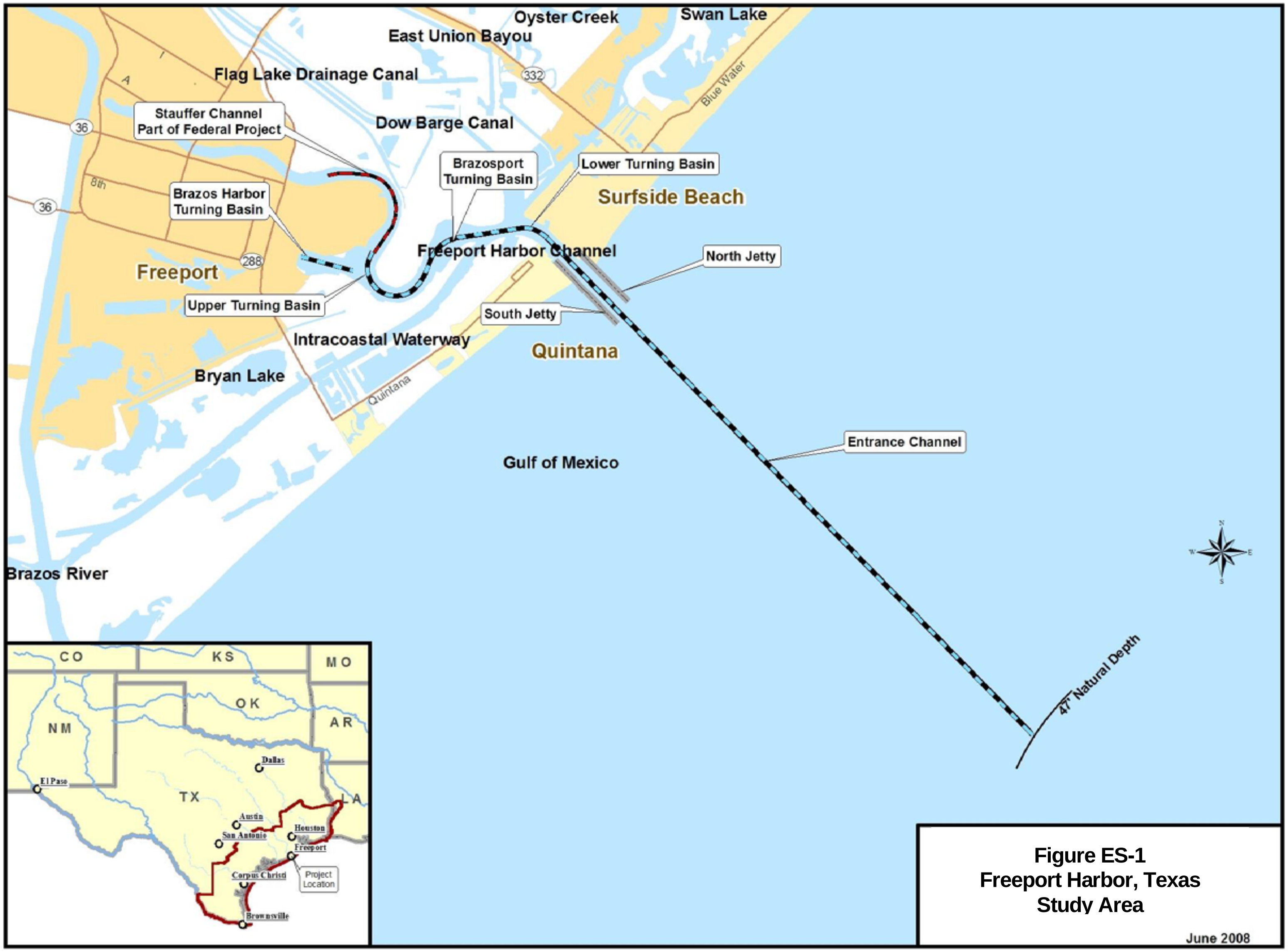


Figure ES-1
Freeport Harbor, Texas
Study Area

June 2008

Figure ES-1
Freeport Harbor Texas
Study Area

Port Freeport (formerly the Brazos River Harbor Navigation District) is the non-Federal sponsor for the study. The study has been coordinated with interested Federal, State, and local agencies, and interested public. In October 2002, a Reconnaissance Report Section 905(b) Analysis was completed for Freeport Harbor. The Section 905(b) analysis was conducted under authority of Section 216 of the Flood Control Act of 1970. The reconnaissance evaluation recommended proceeding with a cost-shared feasibility study with the Brazos River Harbor Navigation District as the lead cost-sharing Sponsor. The Feasibility Cost Sharing Agreement was signed July 7, 2003.

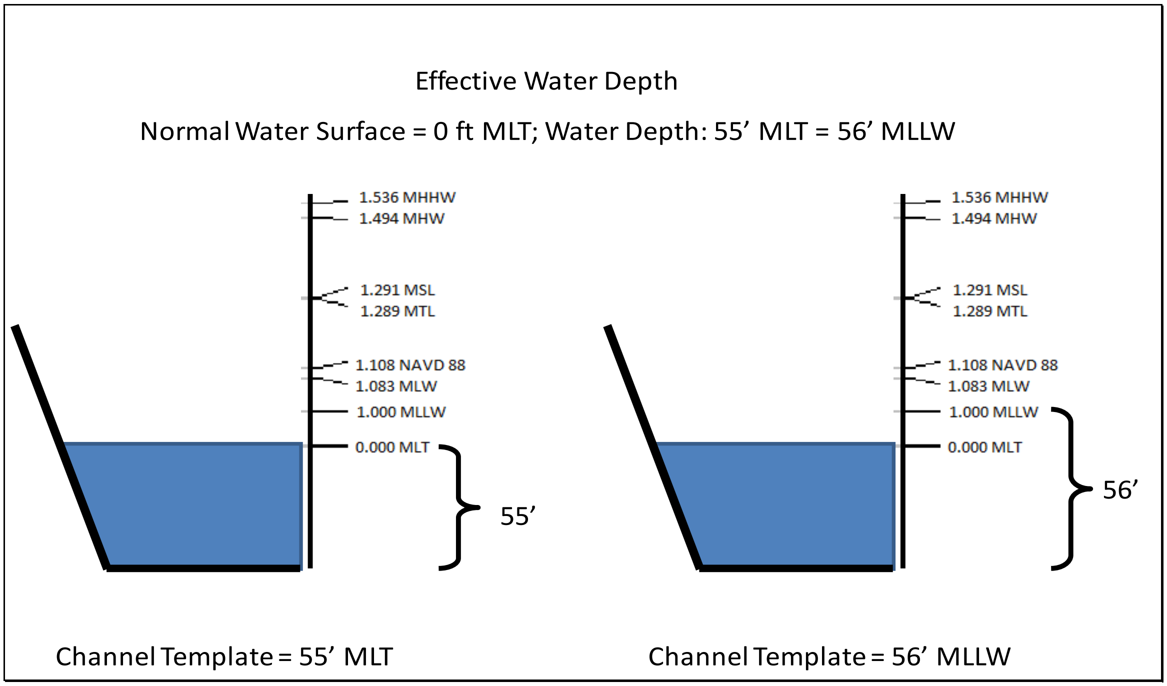
All elevations referred to in this report, unless specifically noted otherwise, are based on USACE Galveston District's local Mean Low Tide (MLT) datum. This project is a compilation of National Geodetic Vertical Datum of 1929 (NGVD 29) and the newer North American Vertical Datum of 1988 (NAVD 88). Existing after-dredged hydro surveys in the local vertical datum of MLT were used in calculating new work volumes. These vertical datum are presented in the studies performed by the Engineer Research and Development Center, and can be referenced for more clarification.

The North American Datum of 1927 (NAD 27) was used during the initial screening of alternatives. After the Feasibility Scoping Meeting, the study was converted to the newer North American Datum of 1983 (NAD 83). Final Plates are shown in NAD 83, Texas State Plane Coordinate System, South Central Zone.

Army regulations and USACE Headquarters guidance on tidal datum, provided in Engineer 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 MLT to Mean Lower Low Water (MLLW). EM 1110-2-1003 further states that MLLW should be tied to the NAVD 88. The predominant reasons for conversion to MLLW are the need for consistency throughout the ports of the U.S., to enhance the continuity of National Oceanic and Atmospheric Administration and U.S. Coast Guard (USCG) navigation charts, and to avoid misconceptions within the shipping and dredging industries with regard to channel depths.

The USACE Galveston District has an established survey control network along the Freeport Harbor Channel. To comply with the above-referenced guidance on referencing tidal datums using MLLW, the Galveston District took vertical survey measurements at tide gages and benchmarks to estimate the relative difference between MLT and MLLW datums along the Freeport Channel. The objective was to maintain an effective water depth of 55 feet while correctly referencing resulting water surface level in MLLW as shown in the following Figure ES-2.

Figure ES-2
Effective Water Depth
Freeport Harbor Channel
Mean Low Tide – Mean Lower Low Water



At Freeport Channel, datum values for MLLW are +1 foot above MLT. However, this does not result in increased water depth, as the additional +1 foot of nominal depth is actually +1 foot above the normal surface water level. Therefore, the actual water depths are equivalent between a 55-foot MLT channel template and a 56-foot MLLW channel template.

As the study and its documentation were completed using MLT, references to MLT have been maintained throughout this document, though numbers are also referenced in MLLW depths at some locations in the report. These references are in parentheses and the datum is referenced at each reference point.

The Recommended Plan addresses the problems and opportunities identified during the study and satisfies the planning objectives of increasing navigation efficiency and safety along the Freeport Harbor Channel while maintaining the coastal and estuarine resources within the project area. This Recommended Plan is the Locally Preferred Plan (LPP), the plan preferred by the Sponsor. The LPP is recommended in lieu of the National Economic Development (NED) Plan. The NED Plan and the LPP were fully developed. The LPP is less costly than the NED Plan for the Entrance and Main channels and the net excess benefits are less.

Based on the economic, engineering, and environmental factors considered, the LPP includes deepening of the Outer Bar Channel from the jetties into the Gulf of Mexico to –57 feet MLT (–58 feet MLLW); deepening from the end of the jetties in the Gulf of Mexico to the Lower

Turning Basin to –55 feet MLT (–56 MLLW); deepening the Main Channel from the Lower Turning Basin to Sta. 132+66 (ConocoPhillips dock area, above 1,200-foot Brazosport Turning Basin) to –55 feet MLT (–56 feet MLLW); deepening of Freeport Harbor from Sta. 132+66 through the Upper Turning Basin to –50 feet MLT (–51 feet MLLW); deepening and widening the lower 3,700 feet of the Stauffer Channel at a depth of –50 feet MLT (–51 feet MLLW) and 300 feet wide; and dredging the remainder of the Stauffer Channel to a depth of –25 feet MLT (–26 feet MLLW), in lieu of restoring it to its previously authorized dimensions of 30 feet by 200 feet. Depths shown exclude advance maintenance and allowable overdepth. It is estimated that the approximately 17.3 million cubic yards of new work material (including advance maintenance and allowable overdepth) would require eight separate dredging contracts to complete. The work is estimated to begin in 2015 and be complete by 2021. Dredged material management will be performed according to the Dredged Material Management Plan.

The project benefits were calculated for a 2017–2067 period of analysis using the Fiscal Year (FY) 12 Federal discount rate of 4.0 percent and the deep-draft vessel operating costs contained in Economic Guidance Memorandum 08-04. The proposed channel improvements are in response to the need for deeper access required by liquid bulk vessels, the introduction of larger vessels, and the reauthorization of the upper reaches of the harbor. The deepening and widening of the Freeport Harbor Channel will generate annual benefits of $41,814,000 with total annual costs of $25,068,000, producing a benefit-cost ratio of 1.7. At a discount rate of 7 percent, annual benefits of $38,082,000 and total annual costs of $26,333,000 produce a benefit-cost ratio of 1.4.

The project first cost of all project components totals $232,121,400. The fully funded project cost of all components totals $247,485,000.

The total cost for the Recommended Plan is $290,652,000, as shown in Table ES-1. Costs include implementation costs and associated costs. Implementation costs include post-authorization planning and design costs, construction costs, construction contingency costs, and Operation and Maintenance (O&M) costs. Construction costs include costs for dredging and placement area construction. Costs for fish and wildlife mitigation are also included. No cultural resource mitigation costs are expected at this time. A programmatic agreement is in effect for any cultural resource mitigation, if required at a later date. Aids to navigation (estimated at $1,352,000) are provided by the USCG, and are a Federal cost included in the economic justification, but are not subject to project cost sharing. Construction General funding will fund Federal share of all project construction.

Table ES-1
Recommended Plan Cost
Comparison of Costs (rounded) October 11

Cost Account	Item Description	First Cost (Oct 11 Price Level)	Fully Funded Cost (Oct11 Price Level)
Federal Construction Cost			
01	Lands & Damages	-0-	-0-
06	Fish & Wildlife Facilities	61,000	180,000
12	Navigation Ports & Harbors	203,389,000	219,370,000
30	Planning, Engineering & Design	17,726,000	19,606,000
31	Construction Management	9,192,000	10,595,000
Federal Construction		**230,468,000**	**249,751,000**
Non-Federal (LERRs/ Associated) Cost			
01	Lands & Damages	1,653,000	1,753,000
02	Relocations	-0-	-0-
12	Navigation Ports & Harbors (1)	57,179,000	61,829,000
Non-Federal Construction		**58,832,000**	**63,582,000**
Aids to Navigation		**1,352,000**	**1,456,000**
Total Navigation Costs		**290,652,000**	**314,788,000**

(1) Costs include $38,800,000 in non-Federal bulkhead modifications and 18,379,000 in dredging costs for berthing areas adjacent to the Federal channel.

Project costs and price escalation (calculated by estimating the midpoint of the proposed contracts) are combined to create the Fully Funded Cost. The Project First Cost for all project components is separated into expected non-Federal and Federal cost shares and detailed in Table ES-2. These costs are accurately apportioned at different cost share rates based on the work being done at different depths. For a majority of the work where the existing channel is currently at 45-foot MLT (46-foot MLLW), the work will be cost shared 50 percent Federal/50 percent non-Federal. On the Stauffer Channel where the existing depths are less than 20 feet and depths are proposed to go to 50 feet MLT (51 feet MLLW), cost share will cover all levels including 90/10 Federal/non-Federal, 75/25, and 50/50. Where Stauffer Channel is proposed to go to 25 feet MLT (26 feet MLLW), cost share will be both the 90/10 and 75/25 cost shares.

Table ES-2
Cost Apportionment

Cost Apportionment Navigation*	First Cost ($)	Fully Funded Cost ($)
Federal Navigation:		
Freeport Channel	108,029,000	115,262,000
Lower Stauffer Channel	7,520,000	7,958,000
Upper Stauffer Channel	2,719,000	2,876,000
Lands & Damages	-0-	-0-
Mitigation	134,000	142,000
Total Federal Navigation	**118,402,000**	**126,238,000**
non-Federal Navigation:		
Freeport Channel	108,029,000	115,262,000
Lower Stauffer Channel	3,104,000	3,284,000
Upper Stauffer Channel	806,000	852,000
Land & Damages	1,653,000	1,713,000
Mitigation	127,000	136,000
Total non-Federal Navigation	**113,719,000**	**121,247,000**
Total Navigation	**232,121,000**	**247,485,000**

*Costs include Preconstruction Engineering & Design and Construction Management totals.

The USACE prepared a Final Environmental Impact Statement (FEIS) as required by the National Environmental Policy Act (NEPA) to present an evaluation of potential impacts associated with the proposed Freeport Harbor project. The FEIS has been properly prepared and coordinated as required by NEPA. All factors that may be relevant to the proposed project were considered, including dredged material management, air quality, shoreline erosion, historic resources, protected species, recreation, water and sediment quality, energy needs, safety, hazardous materials, and, in general, the welfare of the people. Areas of potential impact identified include water and sediment quality, air quality, noise, riparian forest and wetlands, terrestrial and aquatic wildlife (including Essential Fish Habitat), protected species, cultural resources, land use, and socioeconomics. For the proposed project, the majority of potential project-related impacts were avoided. Mitigation was proposed only for impacts to riparian forest and wetland habitats. Public involvement occurred through public meetings and other outreach efforts throughout the history of the project. The public, State and Federal resource agencies, industry, local government, and other interested parties have been proactively informed about the project.

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Acronyms and Abbreviations

3D	three dimensional
AAHU	Average Annual Habitat Unit
AEO	Annual Energy Outlook
ASA(CW)	Assistant Secretary of the Army (Civil Works)
BA	Biological Assessment
BCR	Benefits-to-Cost Ratio
BO	Biological Opinion
BOEM	Bureau of Ocean Energy Management, Regulation and Enforcement, formerly the Minerals Management Service (MMS)
BPD	Barrels per Day
BRPA	Brazos River Pilots Association
CBRA	Coastal Barrier Improvement Act
CE/ICA	Cost Effectiveness and Incremental Cost Analysis
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act (80)
CFR	Code of Federal Regulations
CHL	Coastal Hydraulics Laboratory
cm	centimeter
cm/sec	centimeters per second
CWA	Clean Water Act
cy	cubic yards
dB	Decibel
dBA	sound levels measured using A-weighting
DMMP	Dredged Material Management Plan
DOE	U.S. Department of Energy
DWT	Deadweight Tonnage
DX	Directorate of Expertise
EC	Engineering Circular
EFH	Essential Fish Habitat
EGM	Economic Guidance Memorandum
EIA	Energy Information Administration
EIS	Environmental Impact Statement
EJ	Environmental Justice
EM	Engineer Manual
EO	Executive Order
EOP	Environmental Operating Principles
EPA	U.S. Environmental Protection Agency
EQ	Environmental Quality

ER	Engineer Regulation
ERDC	Engineer Research and Development Center
ESA	Endangered Species Act (73)
ETL	Engineer Technical Letter
FEIS	Final Environmental Impact Statement
FPPA	Farmland Protection Policy Act
ft/sec	feet per second
ft/yr	feet per year
FTZ	Foreign Trade Zone
FWOP	Future Without-Project
FWP	Future With-Project
FY	Fiscal Year
GIWW	Gulf Intracoastal Waterway
GLO	Texas General Land Office
GNF	General Navigation Feature
GDP	gross domestic product
H&H	Hydrology and Hydraulics
HEP	Habitat Evaluation Procedures (Ecosystem Evaluation)
HGB	Houston-Galveston-Brazoria
HQ	USACE Headquarters
HSI	Habitat Suitability Index
HTRW	Hazardous, Toxic, and Radioactive Waste
HU	habitat unit
IPCC	Intergovernmental Panel on Climate Change
IWR	Institute of Water Resources
LER	lands, easement, and rights-of-way
LERR	lands, easements, rights-of-way, and relocations
LNG	Liquefied Natural Gas
LOA	(Ship) Length Overall
LPP	Locally Preferred Plan
m^3	cubic meter
mcy	million cubic yards
mcy/yr	million cubic yards per year
MDFATE	Multiple Disposal Fate model
MLLW	Mean Lower Low Water
MLT	Mean Low Tide
mm/yr	millimeters per year
MMS	Mineral Management Service, now the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEM)

NAD 27 (or 83)	North American Datum of 1927 (or 1983)
NAVD 88	North American Vertical Datum of 1988
NDC	Navigation Data Center
NED	National Economic Development
NEPA	National Environmental Policy Act (69)
NGVD 29	National Geodetic Vertical Datum of 1929
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NO_x	Nitrogen oxides
NRC	National Research Council
NRCS	Natural Resources Conservation Service
O&M	Operation and Maintenance
ODMDS	Ocean Dredged Material Disposal Site
OSE	other social effects
OSV	offshore supply vessels
PA	Placement Area
PADD	Petroleum Administration Defense District
PAg	Programmatic Agreement
PED	Preconstruction Engineering and Design
PGL	Planning Guidance Letter
PL	Public Law
PSV	platform supply vessel
RED	Regional Economic Development
RHA	River and Harbor Act
RRC	Railroad Commission of Texas
RSLR	Relative Sea Level Rise
SAV	submerged aquatic vegetation
SH	State Highway
SHPO	State Historic Preservation Officer
SIP	State Implementation Plan (CAA)
SMMP	Site Monitoring and Management Plan
SOC	species of concern
SPR	Strategic Petroleum Reserve
SPT	Standard Penetration Tests
TCEQ	Texas Commission on Environmental Quality (formerly Texas Natural Resources Conservation Commission [TNRCC])
TEPPCO	Texas Eastern Petroleum Pipeline Company
TEU	Total Equivalent Units (Container – 20 x 8 x 8) (7.5 metric tons)
TPCS	Total Project Cost Summary

TPWD	Texas Parks and Wildlife Department
TWDB	Texas Water Development Board
TxDOT	Texas Department of Transportation
TY	target year
UC	Unconfined Compression Tests
USACE	U.S. Army Corps of Engineers
USC	United States Code
USCG	U.S. Coast Guard
USFWS	U.S. Fish and Wildlife Service
UU or Q-tests	Unconsolidated Undrained Triaxial Compression Tests
VE	Value Engineering
VLCC	Very Large Crude Carrier
WCSC	Waterborne Commerce Statistics Center
WRDA	Water Resources Development Act

1.0 INTRODUCTION

Freeport Harbor provides deepwater access from the Gulf of Mexico to Port Freeport. The waterway extends from deep water in the Gulf through a 0.83-mile jettied channel to the Lower Turning Basin, then westerly approximately 1.5 miles to and including the Brazosport Turning Basin, then westerly approximately 2.2 miles through the Upper Turning Basin to and including a turning basin at Brazos Harbor. The Stauffer Channel extends 1.15 miles from the Upper Turning Basin to the Stauffer Turning Basin. The study area is shown on Figure 1.

The existing authorized depth for the Freeport Harbor Channel is 45 feet mean low tide (MLT). All elevations referred to in this report, unless specifically noted otherwise, are based on the U.S. Army Corps of Engineers (USACE) Galveston District's local MLT datum. This project is a compilation of National Geodetic Vertical Datum of 1929 (NGVD 29) and the newer North American Vertical Datum of 1988 (NAVD 88). Existing after-dredged hydro surveys in the local vertical datum of MLT were used in calculating new work volumes. These vertical datum are presented in the studies performed by the Engineer Research and Development Center (ERDC), and can be referenced for more clarification.

An evaluation was performed comparing the elevation data to Mean Lower Low Water (MLLW) and addressing data conversion. This is addressed in further detail in Section 8, Engineering Studies, of this report.

At Freeport Channel, datum values for MLLW are +1 foot above MLT. However, this does not result in increased water depth, as the additional +1 foot of nominal depth is actually +1 foot above the normal surface water level. Therefore, the actual water depths are equivalent between a 55-foot MLT channel template and a 56-foot MLLW channel template.

As the study and its documentation were completed using MLT, references to MLT have been maintained throughout this document, though numbers are also referenced in MLLW depths at some locations in the report. These references are in parentheses and the datum is referenced at each reference point. Authorized project widths of the channel range from 400 feet from the Gulf to the Brazosport Turning Basin to 200 feet for the Brazos Harbor Channel. Brazos Harbor Channel and Turning Basin are 36 feet MLT (37 feet MLLW). The deauthorized Stauffer Channel measures 200 feet wide with a depth of approximately 18 feet (authorized at 30 feet) MLT (19 feet MLLW). The tidal range for Freeport Harbor is typically 2 feet. Construction of the existing 45-foot Freeport Harbor Project was completed in 1993.

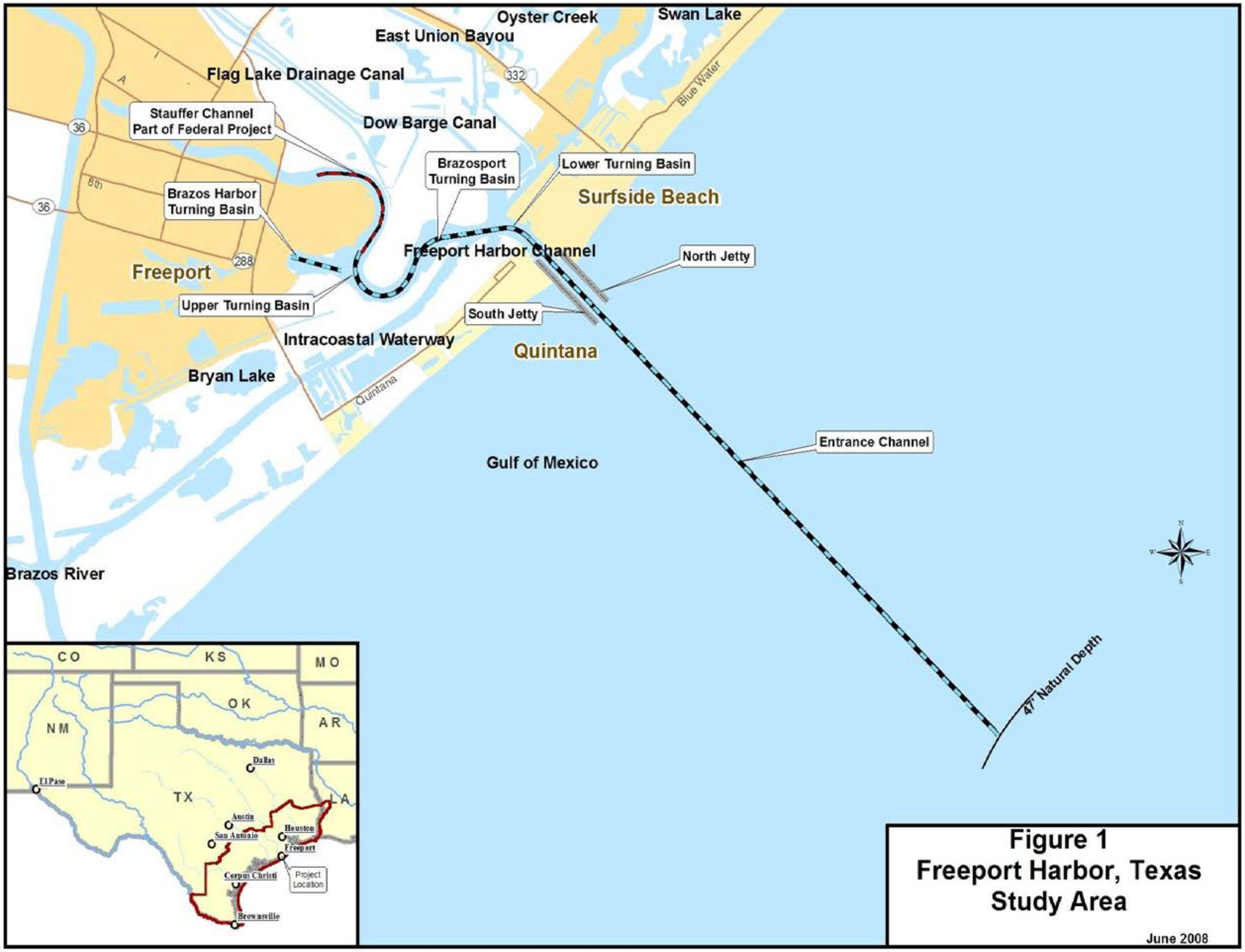

Figure 1
Freeport Harbor, Texas
Study Area
June 2008

The size of ships has steadily increased such that vessels have to be light-loaded to traverse the waterway. The current channel depth requires that large crude carriers remain offshore and transfer their cargo into smaller crude tankers for the remainder of the voyage.

This comprehensive navigation study investigates the feasibility of improving the Freeport Harbor Channel. This section of the report identifies the study authority, scope, participants and coordination, related studies, and study process.

1.1 PURPOSE AND AUTHORITY

The purpose of this study is to develop and evaluate alternatives for navigation problems that directly affect the Freeport Harbor Channel. To allow for a more effective, safe, and efficient waterway, the study is focused on eliminating the major problems contributing to inefficiencies on the waterway, such as insufficient channel depth and width, as determined by fleet forecasts and the requirement for one-way and daylight-only traffic in the channel. The study also identifies economic benefits associated with sponsor-proposed channel modifications and recommends alternatives that maximize these benefits. Authority for the study is contained in Section 216 of the 1970 Flood Control Act:

> *Section 216. The Secretary of the Army, acting through the Chief of Engineers, is authorized to review the operation of projects the construction of which has been completed and which were constructed by the Corps of Engineers in the interest of navigation, flood control, water supply, and related purposes, when found advisable due to significantly changed physical or economic conditions, and to report thereon to Congress with 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 feasibility study is being conducted to determine whether navigation problems currently being experienced at Freeport Harbor are in the Federal interest and to provide the documentation needed to recommend Congressional authorization and funding for construction of that project.

1.2 DESCRIPTION OF THE FREEPORT AREA

Freeport Harbor is located immediately south of the city of Freeport in Brazoria County, Texas, on the middle Texas coast. One of the earliest ports on the Texas coast, a harbor was developed at the mouth of the Brazos River, which was subsequently diverted to the west to an outlet into the Gulf about 6.5 miles southwest of the original mouth, resulting in a ship channel that receives no natural freshwater inflow from the river. The channel and harbor are heavily developed with industrial and commercial properties. Freeport is about 50 miles southwest of Houston. The cities of Surfside Beach and Quintana, Texas, are found on the Gulf shore east and west of the jettied Entrance Channel, respectively. Although extensive coastal marshes are found along this part of the Texas coast, the immediate project area is heavily developed, with limited natural resources remaining.

For purposes of Final Environmental Impact Statement (FEIS) development and analysis, the term “project area” is used to refer to the project footprint and area of direct project impact, defined as the ship channel and dredge disposal sites, including a 1-mile radius around these project features. A broader “study area” incorporates the area of indirect impacts and areas defined by regulation or individual resource. For example, for air conformity purposes, the study area includes the seven counties of the Harris-Galveston-Brazoria (HGB) Ozone Nonattainment Area, while for endangered species purposes, the study area is defined as Brazoria County and the Gulf of Mexico. The study area includes the extensive and rich marsh and estuarine resources of the Texas midcoast, largely lacking from the ship channel project area. The following discussion provides information first on the broader midcoastal study area, then focuses in on the ship channel project area and addresses the resources directly impacted by the project and project mitigation.

1.3 STUDY AREA DESCRIPTION: THE GENERAL FREEPORT AREA ENVIRONMENTAL SETTING

Freeport is located on the Gulf Coastal Plain, which is extremely flat, rising from about 3 feet above sea level behind the beaches to about 15 feet 15 miles inland. The primary physiographic environments of the study area include fluvial deltaic systems, barrier island strandplain systems, and aeolian (wind) systems. The coastal zone within the study area is underlain by sedimentary deposits that originated in ancient, but similar, physiographic environments. These ancient sediments were deposited by the same natural processes that are currently active in shaping the present coastline, such as longshore drift, beach wash, wind deflation and deposition, tidal currents, wind-generated waves and currents, delta outbuilding, and river point bar and flood deposition.

Tidal circulation and mixing in the Gulf of Mexico near Freeport is the result of a complex interaction of tides, meteorological driving forces, freshwater inflows, and Coriolis acceleration. The generally westerly longshore current in the northwestern Gulf of Mexico dominates the hydrodynamic regime near Freeport, resulting in sediment transport to the southwest, which causes shoaling into the Freeport Harbor Entrance (Outer Bar and Jetty) Channel.

The climate of the Freeport area is humid subtropical with warm to hot summers and mild winters. The dominant air mass in summer is marine tropical in which sea breezes moderate afternoon heat. Occasional showers or thunderstorms are common during this season. Winters are mild with considerable day-to-day variation between the marine tropical air mass and modified continental polar and marine polar air masses. Periods of freezing temperatures are infrequent and usually last no longer than 2 or 3 days.

Rainfall averages about 43 inches annually at Freeport. The annual rainfall distribution is greater for the early summer and fall periods and least for the winter and late summer. Two principal wind regimes dominate the area and include persistent southeasterly winds occurring from March through November and strong, short-lived northerly winds from December through February. Severe weather occurs periodically in the area in the form of thunderstorms, tornadoes, and tropical storms or hurricanes.

The study area is characterized as Quaternary (Recent and Holocene) Alluvium containing thick deposits of clay, silt, sand, and gravel, overlying the Pleistocene-aged Beaumont Formation. These formations consist mainly of stream channel, point bar, natural levee, and backswamp deposits associated with former and current river channels and bayous. The Alluvium outcrops in a belt approximately 70 to 90 miles wide paralleling the Texas coastline. The underlying Beaumont Formation is estimated to be less than 1,000 feet thick and consists mostly of clay, silt, sand, and gravel. Subsidence is estimated to be 2.65 millimeters per year (mm/yr), and relative sea level rise (RSLR) is projected to be between 0.5 mm/yr and 2.65 mm/yr (FEIS Appendix L).

The Gulf Coast Aquifer system is the principal source of groundwater for public, agricultural, and industrial needs in the Freeport area. Within the aquifer system, the Chicot Aquifer is the uppermost aquifer, and all public and private water-supply wells in the area are supplied by this aquifer (Texas Water Development Board [TWDB], 2007). The Evangeline Aquifer underlies the Chicot and is noted for its abundance of good-quality groundwater and is considered one of the most prolific aquifers in the Texas Coastal Plain (Baker, 1979), but is not used in the Freeport area.

1.3.1 Air Quality

Freeport is included in the eight-county HGB Ozone Nonattainment Area, which is in attainment or unclassified for all criteria pollutants except ozone and is classified as having “severe” nonattainment with the 1-hour and the 8-hour National Ambient Air Quality Standards for ozone. Under the “severe” attainment designation, the HGB has a deadline of June 15, 2019, for attainment of the 8-hour ozone standard. The 1-hour attainment is still pending (40 *Code of Federal Regulations* [CFR], Part 81) (*Federal Register*, Vol. 73, No. 191). Because the proposed project is located in the HGB nonattainment area for ozone, a General Conformity Determination was prepared and the Recommended Plan was found to be in conformity with the current State Implementation Plan (SIP) (Texas Commission on Environmental Quality [TCEQ], 2007).

1.3.2 Fish and Wildlife Resources

The study area contains estuarine, wetland, and upland habitats that support a variety of fish and wildlife resources. Since the study area has tidal and freshwater habitats, wildlife species are diverse. The area also supports productive sport and commercial fishing. Due to the diversity of bird life, bird watching is an important recreational activity.

Upland Resources. The study area supports a diverse population of upland wildlife species. Uplands include developed areas, dunes and relict beach ridges, grassland/pastures, scrub/shrub vegetation, and woodlands. An important ecosystem that occurs within the study area is the Columbia Bottomlands, which is located in the floodplains of the Brazos, San Bernard, and Colorado rivers north and west of Freeport. The Columbia Bottomlands support uplands and wetlands including marshes, forested wetlands, small-scattered prairies, and bottomland hardwood forests that are important stopping points for migratory birds of the Central and Mississippi flyways.

The immediate study area and vicinity support an abundant and diverse avifauna. Common species of potential occurrence in the study area include great blue heron, great egret, snowy egret, little blue heron, white ibis, roseate spoonbill, clapper rail, grebes, pelicans, cormorants, ducks, geese, hawks, rails, plovers, sandpipers, gulls, doves, owls, hummingbirds, swallows, purple martins, wrens, thrushes, mockingbirds, blackbirds, grackles, cowbirds, and others.

Common terrestrial mammals include the Virginia opossum, various rodents, eastern cottontail, raccoon, striped skunk, coyote, bobcat, and white-tailed deer. Terrestrial amphibian and reptile species of potential occurrence in the study area include Blanchard’s cricket frog, Gulf Coast toad, green treefrog, American bullfrog, small-mouthed salamander, western diamond-backed rattlesnake, cotton-mouthed moccasin, American alligator, diamondback terrapin, and other species.

National wildlife refuges within the study area include the Brazoria and San Bernard. In addition to the two Federal refuges, there is a state wildlife management area (Justin Hurst) located about 5 miles west of Freeport. Local sanctuaries include the Neotropical Bird Sanctuary and the Xeriscape Park administered by the town of Quintana.

Aquatic Resources. The study area consists of both marine and freshwater ecosystems that support ecological diversity and abundance. A general overview of the marine and freshwater resources present within the study area is described below.

Marine Resources. The entire food chain of open-water areas is dependent on the microscopic plankton that provides an abundant food source for fish and other marine life. The open-water bottom is dominated by benthic organisms, including epifauna, such as crabs and smaller crustaceans, and infauna, such as mollusks and polychaetes. These organisms support other important resources including Essential Fish Habitat (EFH), which is defined as those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. The study area is located in an area that has been identified as EFH for juvenile and adult brown, pink, and white shrimp and juvenile and adult gray snapper, red drum, Spanish mackerel, and others. EFH for the species known to occur in the study area includes estuarine emergent wetlands, estuarine mud, sand, and shell substrates, estuarine water column, and nonvegetated bottom.

Coastal Wetland Resources. Study area coastal wetlands (saline to freshwater) provide essential habitat for fish, shellfish, and other wildlife. Coastal wetlands also serve to filter and process agricultural and urban runoff and buffer coastal areas against storm and wave damage. Wetland plant communities that occur in the study area include submerged aquatic vegetation (SAV) including shoalgrass and widgeongrass; estuarine salt and brackish marshes of smooth cordgrass, saltgrass, bulrush, and glasswort; estuarine tidal flats with less than 30 percent vegetative cover of glasswort, saltwort, and shoregrass; freshwater aquatic vegetation including invasives like water hyacinth and natives like arrowhead; and freshwater marshes including spikerush, flat-sedge, rushes, smartweed, coastal water-hyssop, seashore paspalum, bulrush, and cattails.

1.3.3 Threatened, Endangered, and Protected Species

A number of threatened, endangered, or protected species may occur in the study area including the whooping crane, piping plover, bald eagle, peregrine falcon, reddish egret, white-faced ibis, wood stork, white-tailed hawk, and possibly the sooty tern. The green, loggerhead, Kemp’s ridley, and hawksbill sea turtles may occur in the study area and could be negatively impacted by dredging. A Biological Assessment (BA) addressing these species and potential impacts is included as Appendix I in the FEIS.

1.3.4 Cultural Resources

Numerous cultural resource investigations, both terrestrial and marine, have been performed in the project area resulting in a well-developed cultural history for this portion of the Texas coast. The aboriginal inhabitants of this region seasonally exploited the Brazos River for its maritime and mainland resources; early European mariners utilized the mouth of the Brazos as a riverine passage to mercantile trade; and the nineteenth-century Austin colonists developed the mouth of the Brazos into commercial and social centers. Therefore, cultural resources characteristic of this area range from prehistoric shell middens to early European shipwrecks to historic period sites such as Fort Velasco and the towns of Quintana and Velasco.

1.3.5 Socioeconomic Considerations

The study area lies within the HGB Metropolitan Statistical Area. The economy of the Freeport area is broadly based in manufacturing, agriculture, and fishing. The development of improved port transportation facilities along the ship channel has allowed greater export of agricultural products and handling of petroleum products. Port Freeport ranked as the 26th largest port in the United States in terms of total tonnage in 2008. Approximately 900 deep-draft vessels call at Port Freeport annually. Most large ship traffic consists of crude or chemical tankers. Containerships also call at Port Freeport. Based on the American Association of Port Authorities, the port handled approximately 72,000 Total Equivalent Units (TEUs) in 2008.

The discovery of oil and natural gas in the area promoted a broad industrial base. Consequently, Freeport has one of the largest petrochemical complexes in the world. Industrial development in the area consists of plants devoted to producing and refining petroleum and petroleum products, petrochemicals, chemical derivatives, and primary metals. Related industries include offshore service vessels, drilling rigs, offshore producing platforms, and offshore service equipment.

Commercial and recreational fishing is also important to the regional economy. The fisheries found in the study area are generally classified as estuarine or marine. The most important commercially harvested species that inhabit estuarine and coastal waters in the study area are brown and white shrimp, southern flounder, and blue crabs. Recreational fish catches include speckled trout, redfish, sand trout, southern flounder, black drum, and shrimp and crabs in the inshore area. Offshore catches include ling, red snapper, amberjack, king mackerel, and Spanish mackerel. Scattered reefs of Eastern oysters are present in areas east of Freeport surrounding Oyster Creek, and scattered oysters are found in many of the nearby open-water areas including Swan and Bryan lakes; however, oysters are not commercially harvested.

The Freeport area is a popular recreational area, and tourism is an important aspect of the local economy. Recreational fishing, hunting, and birding have emerged as important factors in the area economy since the 1960s. The diversity of coastal habitats in the Freeport area supports a large diversity of shore birds, while the large number of adjacent shallow lakes and grain fields create an ideal habitat for waterfowl and migratory birds.

Brazoria County’s population increased from 191,707 in 1990 to 304,844 in 2009, with a rate of increase higher than the state. The county’s population was estimated at 249,832 in 2001. Freeport increased from 11,845 in 1990 to 13,477 in 2009. These population increases have been driven primarily by the development of the petrochemical industry since 1940, with recent contributions by tourism. Projections by the Texas State Data Center indicate that the county will reach a population of 416,157 in 2040.

1.4 PROJECT AREA DESCRIPTION

The project area for the Freeport Harbor Channel Improvement Project is the existing Freeport Harbor 45-foot MLT (46-foot MLLW) navigation project, including the construction footprint of the Recommended Plan, the existing New Work and Maintenance Ocean Dredged Material Disposal Sites (ODMDSs), and the three upland confined Placement Areas (PAs) (existing PA 1 and newly designated PAs 8 and 9), plus a 1-mile radius around all of these project features (Figures 2 and 17). The existing and proposed project is geographically divided into four main channel segments and associated reaches: the Outer Bar Channel and reaches, Main Channel and reaches, Brazos Harbor Channel, and Stauffer Channel. Figure 2 shows the Freeport Harbor main channels and existing PAs. The existing authorized project dimensions are shown in Table 1.

Table 1
Authorized Freeport Harbor Dimensions

Channel Segment	Depth in feet MLT (MLLW)	Width (feet)	Length (miles)
Outer Bar Channel			
Outer Bar Channel	47(48)	400	5.68
Jetty Channel	45(46)	400	1.35
Lower Turning Basin	45(46)	750	0.14
Main Channel			
Channel to Brazosport Turning Basin	45(46)	400	0.50
Brazosport Turning Basin	45(46)	1,000	0.19
Channel to Upper Turning Basin	45(46)	350–375	1.08
Upper Turning Basin	45(46)	1,200	0.23
Brazos Harbor			
Channel to Brazos Harbor	36(37)	200	0.51
Brazos Harbor Turning Basin	36(37)	750	0.13
Stauffer Channel (Deauthorized)			
Channel to Stauffer Turning Basin	30(31)	200	1.34
Stauffer Turning Basin	30(31)	500	0.09

1.5 ENVIRONMENTAL SETTING

The Gulf of Mexico and the Lower Turning Basin bound the Outer Bar Channel. The North and South jetties that protect a portion of the Outer Bar Channel are 7,700 and 6,640 feet long, respectively, and extend into the Gulf from the beachfront communities of Surfside Beach and Quintana, stabilizing the original river mouth at Freeport. The Main Channel reaches extend westerly and then northerly, connecting a series of turning basins beginning downstream at the Lower Turning Basin, then proceeding upstream to the Brazosport and Upper turning basins.

In general, the landward portion of the project area encompasses areas dominated by industrial, commercial, and residential development with some recreation areas, as well as scattered agricultural land and some remnant marshes, all of which are centered around the Freeport Harbor Channel. Prior to the diversion of the Brazos River, the channel was the mouth of the Brazos River. Currently, the Freeport Harbor Channel extends into the Gulf, with no associated bay or estuary, and dead-ends upstream just before reaching State Highway (SH) 288, after passing through the city of Freeport. The community of Surfside Beach is located immediately northeast of the Freeport Harbor Jetty Channel, and Quintana is located immediately to the southwest. Both communities are small beachfront residential areas along public-access beaches. Surfside Beach has been affected by erosion, with homes currently being removed from the beach in efforts to proceed with beach nourishment and shoreline stabilization projects. Quintana is located adjacent to the Seaway upland confined dredged material disposal area and the Freeport Liquefied Natural Gas (LNG) facility. Just past that facility, the Gulf Intracoastal Waterway (GIWW) crosses Freeport Harbor Channel. From that point, industrial complexes, such as Dow Chemical Company and ConocoPhillips Petroleum facilities, line the banks of the channel until the transition into the city of Freeport. Brazos Harbor, located west of the Upper Turning Basin, contains the majority of port facilities.

The Stauffer Channel extends from the Upper Turning Basin upstream to the Stauffer Turning Basin (see Figure 2). The Stauffer Channel was authorized as a 30-x-200-foot channel. However, it was never federally constructed. The channel currently has a depth of approximately –18.0. This channel was deauthorized in 1974 under Section 12 of the Water Resources Development Act (WRDA) of 1974 (Public Law [PL] 93-251). No objections to deauthorization were raised at the time. Various commercial fishery, marine businesses, and recreational facilities are located along the Stauffer Channel. Several pipelines also cross the existing navigation project channel, but all are of sufficient depth and will not be impacted by proposed channel improvements.

The shoreline on both the Surfside Beach (northern) and Quintana Beach (southern) areas has changed substantially over the last 150 years. Most of the Texas shoreline is now in retreat because of RSLR and a reduced supply of sand from changes to the Mississippi and Atchafalaya river systems and from reservoirs built on Texas rivers. A major shoreline change factor for the Freeport area was the Brazos River diversion in 1929 to control excessive dredging requirements in Port Freeport. The relocation had the unanticipated side effect of moving the main source of sediment away from the immediate project area beaches. Another factor has been reservoir development in the Brazos River watershed that, while essential for water supply and flood control, has greatly reduced the sand supply at the relocated Brazos River mouth. The biggest rate of shoreline change occurs with severe storms.

Other major factors are RSLR that moves the shoreline inland and a movement of sand from the beach inland by aeolian drift (wind) aggravated by beach vehicle traffic. Finally, there has been the interception of sand from the longshore system by the navigation channel and jetties. The jetties act as groins to block longshore sediment movement, but some material gets around and through the jetties and must be periodically dredged from the Freeport Harbor Outer Bar and Jetty channels.

Figure 2
Freeport Harbor Channel

Prepared for: USACE, Galveston District	
Job No.: 044190100	Scale: 1 inch equals 4,200 feet
Prepared by: A.Christiansen	Date: 08/06/2008

File: N:/Clients/U_Z/USACE/Projects/Freeport/044190100/projects/Figures/Figure_2.mxd

Note:

This page and the placeholder for Figure 2 before it will be replaced by 11-by-17-inch pages.

1.5.1 Fish and Wildlife Resources

It should be noted that because of urban and industrial development over many decades, habitat types in much of the project area have been disturbed to the point where original species composition and diversity found prior to major development no longer exist. Consequently, much of the project area and the project footprint is devoid of significant biological resources and sensitive habitats, and has low ecological value.

Upland Resources. Natural habitats within the project footprint are highly fragmented due to human disturbance. Upland areas immediately along the ship channel contain broadly scattered grasses, sparse stands of shrub vegetation including invasive salt cedar and big leaf sumpweed, as well as small fringes of giant reed. Grasslands that may occur within the project area include pastures dominated by introduced species including bermudagrass and bahiagrass. Remnant coastal prairie plant species including little bluestem, brownseed paspalum, indiangrass, rosettegrass, and thin paspalum may still be found on the converted pasturelands used for grazing and haying. There are also fragmented and often isolated wetlands, flooded borrow pits, ditches, and other open-water areas in the project area.

Two proposed upland PAs (PAs 8 and 9) would be required for both new work and maintenance material from the Recommended Plan. These proposed new PAs are located northwest of the ship channel, west of the Brazos River Diversion Channel, and north of SH 36, and are currently used as pasture. Construction of PA 9 would impact 39 acres of ephemeral freshwater wetlands in the pasture, and 21 acres of riparian forest adjacent to the Brazos River Diversion Channel.

Marine Resources. The project area is located in an area that has been identified as EFH for juvenile and adult brown, pink, and white shrimp and juvenile and adult gray snapper, red drum, Spanish mackerel, and others. EFH that occurs within the project footprint include marine water column and marine nonvegetated bottoms. Although there are a few areas of quality EFH within the project area, the habitat within the project footprint in the Freeport Harbor Channel and areas immediately adjacent to the project footprint is dominated by industrial, commercial, and residential development, which does not represent high-quality EFH. Additionally, marine water column and marine nonvegetated bottoms occur in abundance within the project area and are, therefore, not unique to the area.

Coastal Wetland Resources. The majority of marsh habitat found in the project area does not have a direct hydrologic connection to the Freeport Harbor Channel. Within the project footprint, there are no estuarine or forested wetlands, estuarine tidal flats, freshwater flats, beach or dune habitat, and no SAV.

1.5.2 Threatened and Endangered Species

There are 32 federally and/or state-listed threatened and endangered wildlife species and 9 National Marine Fisheries Service (NMFS)–designated wildlife species of concern (SOC) of potential occurrence in Brazoria County, Texas, and adjacent Gulf waters. Of these, 13 are of possible occurrence in the study area and include the smalltooth sawfish, green sea turtle, hawksbill sea turtle, Kemp's ridley sea turtle, leatherback sea turtle, loggerhead sea turtle, piping plover, whooping crane, blue whale, fin (or finback) whale, humpback whale, Sei whale, and the sperm whale.

A BA has been prepared to coordinate potential impacts to all federally listed species in the project area. This document, presented in FEIS Appendix I, concludes that construction of the proposed project may affect, but is not likely to adversely affect, four sea turtle species (green, hawksbill, Kemp's ridley, and loggerhead). No other impacts to federally listed species are anticipated.

1.5.3 Water and Sediment Quality

TCEQ has designated the old Brazos River Channel Tidal (Freeport Harbor) as Segment 1111. This segment covers a portion of the project area. The designated uses for Segment 1111 are contact recreation (swimming) and high-quality aquatic habitat. Historical sediment analyses reveal no contaminant issues regarding sediment quality in the project area. Analyses indicate that both maintenance and new work dredged material are safe for potential beneficial uses if beneficial uses were feasible, and safe for upland and ocean placement.

1.5.4 Noise

Noise levels in the project area are elevated compared to undeveloped areas along the coast and are affected by petrochemical industry operations, vessel navigation, and vehicular traffic in the Freeport Harbor area.

The magnitude of noise is usually described by its sound pressure, usually in decibels (dB), and dB values are further defined in terms of frequency-weighted scales (A, B, C, or D). The A-weighted scale is most commonly used in environmental noise measurements because it places most emphasis on the frequency range detected by the human ear (1,000–6,000 hertz). Sound levels measured using A-weighting are often expressed as dBA.

Although the vast majority of land use along the ship channel is dominated by commercial and industrial uses, noise-sensitive receivers such as single-family residences, recreational vehicle parks, and recreational areas do occur on both sides of the channel in the communities of Quintana, Surfside Beach, and Freeport.

At a distance of 0.5 mile from the channel, noise levels measured at noise-sensitive receivers within Quintana were found to range from approximately 49 to 61 dBA. The average, ambient outside noise level recorded within Quintana was 55 dBA, which is similar to the goal set by agencies for the outdoor noise environment in residential areas. Maintenance dredging currently occurs on the Freeport Harbor Channel approximately every 10 months and generally includes use of a hopper dredge, which typically produces 87 dBA at 50 feet. The nearest noise-sensitive receivers affected by existing channel maintenance activities are located within Surfside Beach Jetty Park, which is approximately 220 feet from the channel centerline, and the nearest residences at Surfside Beach are located approximately 880 feet from the channel centerline. Worst-case noise levels related to maintenance dredging operations were calculated to be approximately 75 dBA at the Surfside Beach Jetty Park and 63 dBA at Surfside Beach's nearest residences.

1.5.5 Hazardous, Toxic, and Radioactive Waste

A Hazardous, Toxic, and Radioactive Waste (HTRW) assessment was conducted for the project area, in accordance with USACE document Engineering Regulation (ER) 1165-2-132, Water Resource Policies and Authorities–Hazardous, Toxic, and Radioactive Waste (HTRW) Guidance for Civil Works Projects. The purpose of the assessment was to identify "the existence of, and potential for HTRW contamination on lands in the project area, or external contamination which could impact, or be impacted by the proposed project." The findings and recommendations presented in the HTRW assessment are based on information derived from a review of historic aerial photographs, interviews with persons knowledgeable of the area, a review of regulatory agency databases, and a site visit. The assessment revealed that several HTRW sources exist at upland industries that line the banks of the Freeport Harbor Channel. Although these sources exist upland, no active enforcement actions were under way and no HTRW sites were located within the project area footprint. More-detailed information regarding the HTRW assessment can be found in Appendix D-1 of the FEIS that accompanies this document.

1.5.6 Prime and Unique Farmland

A total of six soil series are located within existing PA 1 and proposed PAs 8 and 9. These series include Surfside clay, Velasco clay, Brazoria clay, Clemville silty clay loam, Norwood silt loam, and Pledger clay. Of these series, PA 9 is composed primarily of Brazoria clay, with lesser amounts of Clemville silty clay loam (northeast), Norwood silt loam (east), and Pledger clay (south). All these soils are nearly level nonsaline soils used primarily as pastureland and cropland.

Prime farmland soils are defined by the Secretary of Agriculture as those soils that have the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops. The soil quality, growing season, and moisture supply are available to economically produce sustained high yield of crops when treated and managed, including water management, according to acceptable farming methods. Some soils are considered prime farmland in their native state, and others are considered prime farmland only if they are drained or watered well enough to grow the main crops in the area. There are no designated “unique farmlands” in the State of Texas.

The soils located in PA 9 are classified as prime farmlands, while those in PA 8 are not. Construction of PA 9 will impact approximately 250 acres of prime farmland. According to the Natural Resources Conservation Service (NRCS), PA 9 and the mitigation area do contain soils classified as Important Farmland and are subject to the Farmland Protection Policy Act (FPPA).

1.5.7 Cultural Resources

Both marine and terrestrial archeological surveys were conducted for areas of new construction in the project area. Archival research and field surveys identified potential remains of a Civil War Confederate gun battery at proposed PA 9. No cultural resources were identified at proposed PA 8. A Programmatic Agreement (PAg) was executed among the USACE, Port Freeport, and the Texas State Historic Preservation Officer (SHPO) to ensure compliance with Section 106 of the National Historic Preservation Act for these resources. Further investigation of the potential Civil War gun battery would be undertaken during development of plans and specifications for this project.

1.6 NON-FEDERAL SPONSOR AND COORDINATION

The District Engineer, Galveston District, USACE, is responsible for the overall management of the study and report preparation. Port Freeport (formerly Brazos River Harbor Navigation District) is the non-Federal sponsor for the study. The Brazos River Harbor Navigation District was created in 1925 by the Texas State Legislature. It was created to make improvements for the navigation of inland and coastal waters, for the preservation and conservation of inland and coastal waters for navigation, and for control and distribution of storm and flood waters of rivers and streams in aid of navigation. It was organized and incorporated under the laws of the State of Texas, but is not a State agency. The study is being coordinated with interested Federal, State, and local agencies and the public. The following are some of the agencies and groups that provided input during preparation of the report:

1.6.1 Federal Agencies

- U.S. Fish and Wildlife Service (USFWS)
- U.S. National Marine Fisheries Service (NMFS)
- U.S. Environmental Protection Agency (EPA)
- U.S. Coast Guard (USCG)

1.6.2 State Agencies

- Texas Commission on Environmental Quality (TCEQ)
- Texas General Land Office (GLO)
- Texas Parks and Wildlife Department (TPWD)
- State Historic Preservation Officer (SHPO)
- Texas Department of Transportation (TxDOT)
- Texas Railroad Commission (RRC)

1.6.3 Regional, County, and Local Agencies

- Port Freeport

1.6.4 Other Interests

- Brazos River Pilots Association (BRPA)

In addition, representatives of numerous firms involved in navigation as well as special-interest groups and individuals provided input to the study.

1.7 PRIOR AUTHORIZATIONS

The original project for Federal improvement at Freeport was authorized by the River and Harbor Act (RHA) of June 14, 1880, which provided for construction of jetties for controlling and improving the channel over the bar at the mouth of the Brazos River. The work was started in 1881 and continued until 1886 when operations were suspended for lack of funds. Partial construction of the jetties was accomplished, but the work was not successful in obtaining an adequate depth over the bar. On March 28, 1899, the Brazos River Channel and Dock Company, under authority granted by the RHA of August 21, 1888, started work to provide a navigation channel at the mouth of the Brazos River and thence inland between the banks of the river. The company was unable to finance completion of the work, and on April 25, 1899, in accordance with requirements of the RHA of March 3, 1899, transferred all its works, rights, and privileges to the United States. This constituted the initial authorization for the existing project for Freeport Harbor.

The Federal project known as Freeport Harbor, Texas, is an improvement of the original mouth of the Brazos River that provides for a deep-draft waterway from the Gulf of Mexico to the city of Freeport. A diversion dam about 7.5 miles above the original river mouth and a diversion channel rerouting the Brazos River from the dam to an outlet in the Gulf about 6.5 miles southwest of the original mouth now make Freeport Harbor solely tidal.

The Freeport Harbor waterway has an overall length of about 7.6 miles from deep water in the Gulf of Mexico to the Brazos Harbor Turning Basin. The Stauffer Channel was dredged originally by local interests to a depth of 25 feet over a bottom width of 300 feet, with a 500-foot-square basin area. The RHA of 1935 incorporated the channel into the Federal project and authorized its deepening to 30 feet over a bottom width of 200 feet, and deepening the basin to 30 feet. Prior to deauthorization in 1974, available depths were considered adequate for the using traffic, and the authorized 30-foot depth was not dredged.

The project also provides for construction of a navigation lock in the diversion dam by local interests, when required in the interest of commerce and navigation. The lock has not been required and at present is classified as an inactive element of the project.

The Freeport Harbor Project was authorized by the RHAs of May 1950 and July 1958. The RHAs provided for an Entrance Channel 38 feet deep and 300 feet wide from the Gulf of Mexico to a point inside the jetties and for inside channels 36 feet deep and 200 feet wide to and including the Upper Turning Basin. The 38/36-foot project was completed in 1962. Greater depth and width were authorized by Congress in 1970 (Section 101 of RHA of 1970, PL 91-611; House Document 289, 93rd Congress – 2nd Session, December 31, 1975) and by the president in 1974. These authorizations were for the Jetty Channel to be relocated and deepened to 45 feet, widened to 400 feet, and the North Jetty relocated northward. The relocated Outer Bar Channel was authorized to a 400-foot width, to a 47-foot depth, and to extend approximately 4.6 miles into the Gulf. An FEIS for the project was prepared by the USACE in 1978 (USACE, 1978). In 1978, prior to Federal construction, Seaway Pipeline, Inc., under a Department of Army permit, widened the Outer Bar Channel to 400 feet and the Jetty Channel to 230 feet.

The 45-foot MLT (46-foot MLLW) channel was completed in 1993, including channel and turning basins dredging, relocation of the USCG station, construction of the 3,700-foot North Jetty, construction of public use facilities, rehabilitation of the South Jetty and addition of 500 feet to the North Jetty, and adjustments to a bend near the project's Upper Turning Basin.

There are no bridges across the various channels of the Federal navigation project.

1.8 STUDY AND REPORT PROCESS

In October 2002, USACE completed a Reconnaissance Report Section 905(b) Analysis for Freeport Harbor. This report concluded that channel modifications that would improve the efficiency and safety of the channels appeared feasible. The report recommended detailed studies to quantify the magnitude of the costs and benefits associated with several types of improvements.

This feasibility study follows the recommendations given in the Reconnaissance Report. It includes detailed analyses of a range of improvements and their effectiveness at improving efficiency and safety by allowing the use of larger, more-efficient vessels and reducing delays and vessel casualties. It also includes detailed assessments of environmental, social, and local economic effects of those improvements determined to be most viable from a national economic perspective. Results of this study form the basis for a decision on project implementation, including preconstruction design studies.

The study process provided for a systematic preparation and evaluation of alternate plans that address study area problems and opportunities. The process involved all of the six functional planning steps:

1. Specify Problems and Opportunities
2. Inventory and Forecast Conditions
3. Formulate Alternative Plans
4. Evaluate Effects of Alternative Plans
5. Compare Alternative Plans
6. Select Recommended Plan

The earlier Reconnaissance Report emphasized problem identification and formulation of alternatives. Emphasis in this Feasibility Report is on evaluation of alternatives, assessment of impacts, and selection of a recommended plan.

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2.0 PROBLEM IDENTIFICATION

Existing water resources problems and needs for Freeport Harbor were identified through coordination with Federal and State agencies, area residents, waterway users, and the non-Federal sponsor. Most of the identified problems are not unique to Freeport but are common to many of the areas along the coast of Texas.

2.1 NAVIGATION AND COMMERCE

Since the completion of the 45-foot project, the size of ships using the waterway has steadily increased so that many vessels currently have to be light-loaded to traverse the waterway. The current channel depth requires that large crude carriers remain offshore and transfer their cargo into smaller crude tankers for the remainder of the voyage. This lightering operation takes place in the Gulf of Mexico where the two ships, the mother ship and the lightering ship, come together so that the cargo transfer can take place. Although this operation has been going on for years, the possibility for a collision, oil spill, fire, or other adverse environmental consequences is always present. Deepening the channel will reduce the number of lightering and lightening operations and provide more opportunity for direct shipments. Current projections suggest that crude imports will increase throughout the period of evaluation. As these imports increase, the number of lightering vessels and product carriers will also increase, adding to the shipping delays and congestion.

2.1.1 Historical Traffic Overview

This provides an overview of recent historical traffic for the existing commodity base. The discussion is limited to crude petroleum, petroleum and chemical products, general and container cargo, and LNG.

Freeport experienced strong growth over the past decade, with total tonnage increasing from an average of 16.1 million short tons for 1994–1995 to 28.5 million for 2004–2006. In 2008, Freeport ranked 26th in the Nation in terms of total tonnage, up from 38th in the early 1990s. In terms of foreign imports and exports, Freeport ranked 12th among U.S. ports in 2007, up from 25th in the early 1990s.[1] Approximately 85 percent of Freeport's current tonnage consists of deep-draft movements. The remaining 15 percent consists of shallow-draft GIWW traffic.

Table 2 presents Freeport's tonnage by major commodity groups through 2009. As indicated, petroleum, specifically crude petroleum, dominates total tonnage. Crude petroleum presently represents 75 percent of 2004–2009 ocean-going tonnage. Freeport's crude petroleum imports represented an average of 3.9 percent of the U.S. total and 6.9 percent of Petroleum

[1] USACE, Waterborne Commerce of the U.S., Part 5, National Summary, Institute of Water Resources (IWR)-Waterborne Commerce Statistics Center (WCSC)-09, 2006-2007 and 1991-1993. Commodity-specific tonnages were not available for 2007 as of May 23, 2009.

Administration Defense District (PADD) III. The combination of the channel-deepening project from 40 to 45 feet in the early 1990s and refinery expansions fostered a 178 percent increase in Freeport's crude imports from 1993 to 1998. Over the same period, PADD III imports increased 31 percent and U.S. imports increased by 28 percent. Since 1998, Freeport's growth has leveled and is more comparable to national and regional growth. Statistics published in Institute of Water Resources (IWR)-Waterborne Commerce Statistical Center (WCSC)-09 show Freeport's 2007 total tonnage at approximately 30 million short tons, down from 32 million in 2006. Preliminary data from the U.S. Department of Energy (DOE) show that Freeport's crude oil imports were down in both 2007 and 2008 over 2006; however, review of the 2008 monthly data showed that Freeport crude oil imports were generally higher in 2008 than 2007 for all months except September when Hurricane Ike hit the region.

Table 2
Freeport Harbor Deep-Draft Tonnage (1,000s of short tons)
(1970–2009)

Year	Major Deep-draft Commodities						Total Ocean-going	Inland Waterway Barge Cargo	Total Tonnage
	Crude Oil Imports	Petroleum Products		Chemical Products		Other			
		Imports	Exports	Imports	Exports				
1970	0	0	0	0	1,082	1,209	2,291	2,992	5,283
1980	12,498	221	0	301	1,162	3,117	17,299	2,832	20,131
1990	5,472	17	26	149	1,093	3,407	10,164	4,330	14,494
1991	6,175	38	10	183	967	1,895	9,268	6,398	15,666
1992	5,891	53	14	163	871	2,761	9,753	5,200	14,953
1993	7,025	18	25	176	931	1,564	9,739	4,286	14,025
1994	10,073	259	17	187	1,431	1,483	13,450	4,000	17,450
1995	10,378	1,345	73	344	1,425	1,357	14,922	4,740	19,662
1996	15,074	1,887	27	275	1,418	1,199	19,880	4,691	24,571
1997	16,742	1,863	117	333	1,522	1,272	21,849	4,432	26,281
1998	19,527	1,825	46	255	1,724	1,175	24,552	4,462	29,014
1999	18,321	1,644	39	341	1,633	1,247	23,225	4,851	28,076
2000	19,770	2,054	45	379	2,217	1,685	26,150	4,835	30,985
2001	19,307	2,413	40	583	1,748	1,407	25,498	4,645	30,143
2002	18,019	736	119	663	1,907	1,119	22,563	4,601	27,164
2003	19,672	1,857	87	778	2,104	1,114	25,612	4,925	30,537
2004	20,602	2,873	91	835	2,622	2,093	29,116	4,792	33,908
2005	22,000	1,779	91	691	2,509	1,553	28,623	4,672	33,295
2006	21,706	1,080	109	705	2,551	1,420	27,571	4,576	32,147
2007	18,523	1,046	90	710	2,691	1,005	24,065	5,151	29,216
2008	20,607	955	81	602	2,406	1,347	25,998	3,844	29,842
2009	19,418	220	200	573	1,864	1,063	23,398	4,025	27,363

Source: USACE, Waterborne Commerce of the U.S., Part 2, 1970–2009

The Port of Freeport is contained in a relatively large foreign trade zone (FTZ). The purpose of an FTZ is to attract and promote U.S. participation in international trade and commerce. Merchandise in an FTZ is considered to be outside the U.S. Customs territory. Therefore, the merchandise is subject to duty only when it leaves the FTZ for consumption in the U.S. market. If FTZ merchandise is exported, there is no duty liability. While in the FTZ, foreign merchandise and domestic merchandise may be stored, sold, exhibited, assembled, disassembled, repackaged, distributed, sorted, tested, graded, cleaned, mixed with other merchandise, otherwise manipulated, or destroyed. The merchandise may also undergo manufacturing operations. Merchandise subject to quota may be stored in an FTZ until a closed quota reopens.

Expansion of the Panama Canal is expected to have significant impacts on shipping routes, port development, cargo distribution, and a host of others to the U.S. maritime system. One of its greatest impacts will be felt in the fast-growing container trade where expansion will enable larger vessels to transit the canal. Vessel calls on the East and Gulf coasts are also expected to increase significantly as cargo shifts away from the congested West Coast. Expansion of the canal project is expected to be completed in 2014 and will coincide with the 2017–2067 period of analysis used for the Freeport Harbor evaluation.

2.1.2 Crude Petroleum Import Overview

Table 3 displays Freeport's crude petroleum imports and shows the port's share of the national and regional totals. Freeport's import growth relates to the pipeline distribution network with national links and regional connections from the channel's Seaway and ConocoPhillips terminals. The Seaway pipeline system provides a critical link in the crude oil supply chain for Central and Midwest refining centers.

During the 1990s, partnerships between ConocoPhillips, Texas Eastern Petroleum Pipeline Company (TEPPCO), Seaway, and ARCO authorized the construction of two new storage tanks at Phillips's Sweeny Tank Farm. The two new tanks expanded the shell tank storage capacity at Sweeny from 1.6 million barrels to 2.6 million barrels. The expansion increased the capacity of the Seaway crude system from approximately 223,000 barrels per day (BPD) to the current volume of 260,000 BPD. As indicated, these changes coincided with the completion of the 45-foot project depth and offshore jetty expansion in the mid-1990s.

Approximately 25 percent of the crude oil imported to Freeport is sent from PADD III to PADD II.

While the Energy Information Administration (EIA) shows all of Freeport's crude oil imports being tied to ConocoPhillips's Sweeny refinery, the point of demarcation is one of two docks on the Freeport Harbor Channel. The Sweeny refinery receives crude oil through the Seaway and the ConocoPhillips docks on the Freeport Channel. Approximately 90 percent of Freeport's total crude oil ship tonnage is discharged at Seaway, the remaining 10 percent at the ConocoPhillips dock. Both the Seaway and ConocoPhillips terminals provide access to the regional and national pipeline network. The Sweeny refinery is 28 miles to the northwest of Freeport.

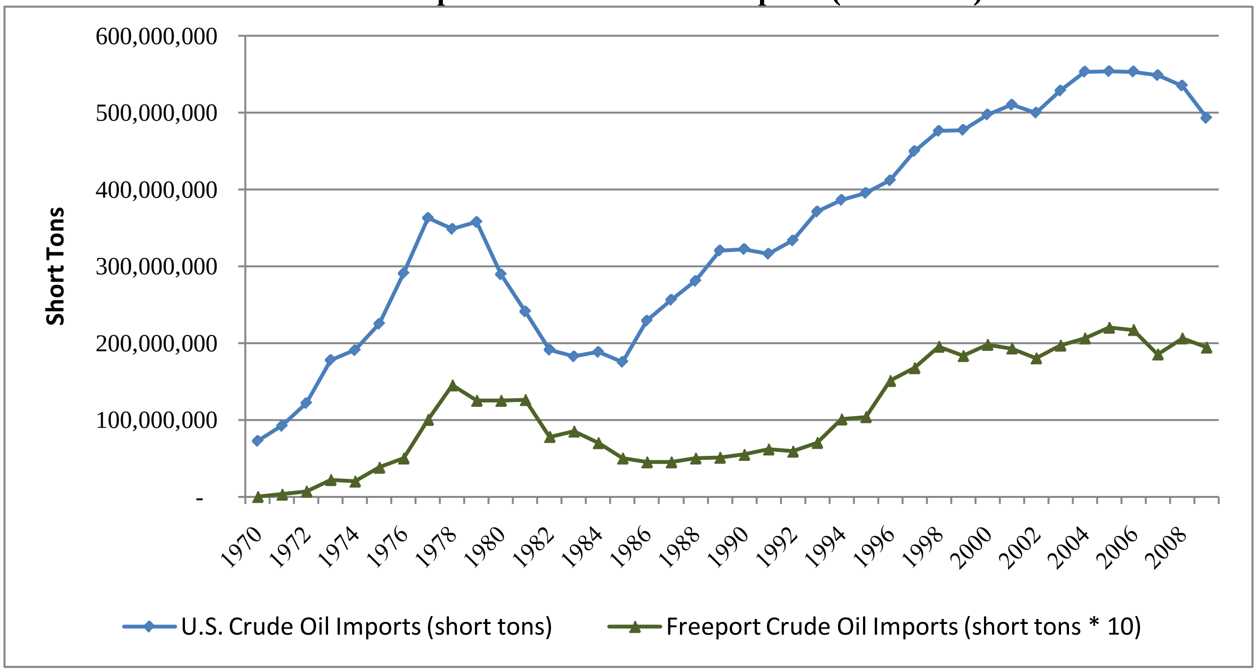
Table 3
Comparison of Freeport and Regional and National Totals
Crude Petroleum Imports (1,000s of short tons)

Year	Freeport Imports	PADD III Imports	U.S. Total Imports	Freeport % of	
				PADD III	U.S. Total
1990	5,472	178,052	322,433	3.1	1.7
1991	6,175	174,852	316,310	3.5	2.0
1992	5,891	184,871	333,666	3.2	1.8
1993	7,025	204,356	371,267	3.4	1.9
1994	10,073	221,020	386,381	4.6	2.6
1995	10,378	222,164	395,484	4.7	2.6
1996	15,074	237,708	411,824	6.3	3.7
1997	16,742	252,270	449,961	6.6	3.7
1998	19,527	267,175	476,231	7.3	4.1
1999	18,321	270,491	477,592	6.8	3.8
2000	19,770	281,170	497,547	7.0	4.0
2001	19,307	292,859	510,298	6.6	3.8
2002	18,019	282,226	499,999	6.4	3.6
2003	19,672	300,325	528,703	6.6	3.7
2004	20,602	316,402	553,337	6.5	3.7
2005	22,000	310,493	553,923	7.1	4.0
2006	21,706	309,399	553,489	7.0	3.9
2007	18,523	306,956	521,948	6.0	3.6
2008	20,607	294,045	535,170	7.0	3.9

Source: USACE and Energy Information Administration (EIA), 1990–2009.

Expectations are that Freeport's imports will grow at rates generally comparable to the regional and national trends. This expectation is based on the study area's established infrastructure of regional and national pipeline distribution links. Comparison of the Freeport and U.S. 1970–2008 period relationship is illustrated on Figure 3.

Figure 3
U.S. and Freeport Crude Petroleum Imports (1970–2009)



Source: USACE, Waterborne Commerce of the U.S., Part 2, 1970–2009 and EIA.

2.1.3 Petroleum and Chemical Product Overview

Regional production includes petroleum products such as transportation fuels, such as gasoline, diesel fuel, and jet fuel, and chemical products such as sodium hydroxide, complex hydrocarbons, and ammonia. For 2004–2006, petroleum and chemical imports and exports totaled 5.3 million short tons. Freeport's products consist primarily of petroleum product imports and chemical exports. Petroleum products are distributed throughout the Midwest and southeastern United States by pipeline, barge, and railcar. Chemicals are primarily distributed by inland waterway barge.

As shown in Table 2, petroleum product imports experienced high growth after 1994. Imports totaled 259 thousand short tons in 1994 and increased to 1.3 million in 1995. The increases experienced in the mid-1990s were associated with lube oil imports, which represented an average of nearly 70 percent of 1995–2000 petroleum product imports. While experiencing tremendous growth from 1994 to 1995, petroleum product imports are variable (see Table 2). In spite of fluctuating volumes, Freeport's share of U.S. petroleum product imports has remained between 1 and 2 percent since the mid-1990s. Freeport's petroleum product exports are much lower than imports and are also variable. Freeport's product exports averaged 97 thousand short tons for 2004–2009. Freeport's petroleum product exports represent less than 1 percent of the U.S. total product export. Table 4 shows Freeport's 1992–2007 percent of the U.S. totals. As shown in Table 4, Freeport exports 4.6 percent of U.S. chemicals. Chemical export volumes for 2004–2007 averaged 2.6 million short tons and represent record highs.

Table 4
Freeport Harbor
Petroleum and Chemical Product Imports and Exports
Freeport Percentages of U.S. Totals

	Petroleum Products		Chemical Products	
Year	Imports	Exports	Imports	Exports
1992	0.1	0.0	1.0	2.1
1993	0.0	0.0	0.9	2.3
1994	0.3	0.0	0.8	3.2
1995	1.7	0.1	1.4	2.9
1996	1.9	0.1	1.1	3.0
1997	1.8	0.2	1.3	3.0
1998	1.5	0.1	0.9	3.4
1999	1.3	0.1	1.2	3.1
2000	1.6	0.1	1.0	3.8
2001	1.8	0.1	1.3	3.2
2002	0.6	0.2	1.7	3.5
2003	1.3	0.2	1.9	3.9
2004	1.7	0.1	1.9	4.3
2005	1.1	0.1	1.5	4.2
2006	1.1	0.1	1.5	4.4
2007	0.6	0.1	1.5	4.6

Source: USACE, Waterborne Commerce of the U.S., Part 2, 1992–2007.

Freeport exports 30.2 percent of U.S. sodium hydroxide; 9.4 percent of U.S. organic chemicals; 9.2 percent of U.S. chemical hydrocarbon; and 7.1 percent of alcohols. In comparison to exports, chemical imports are lower and averaged 768 thousand short tons for 2003–2005, which is three times less than exports. While lower in volume than exports, Freeport imports nearly 15 percent of U.S. chemical hydrocarbons and nearly 8 percent of ammonia.

2.1.4 General and Container Cargo Overview

Freeport's remaining cargo primarily consists of banana imports, rice exports, and outbound coastwise chemical shipments. Distribution of these commodities by major group is displayed in Table 5 and Figure 4. Freeport imports 6 percent of the U.S. banana imports and exports 6 percent of rice exports. Bananas and rice are transported through docks located within the Brazos Harbor Turning Basin where the project depth is 36 feet. Bananas are transported in

Table 5
Freeport Harbor Other Ocean-going Cargo Major Commodities, 1970–2007
(1,000s of short tons)

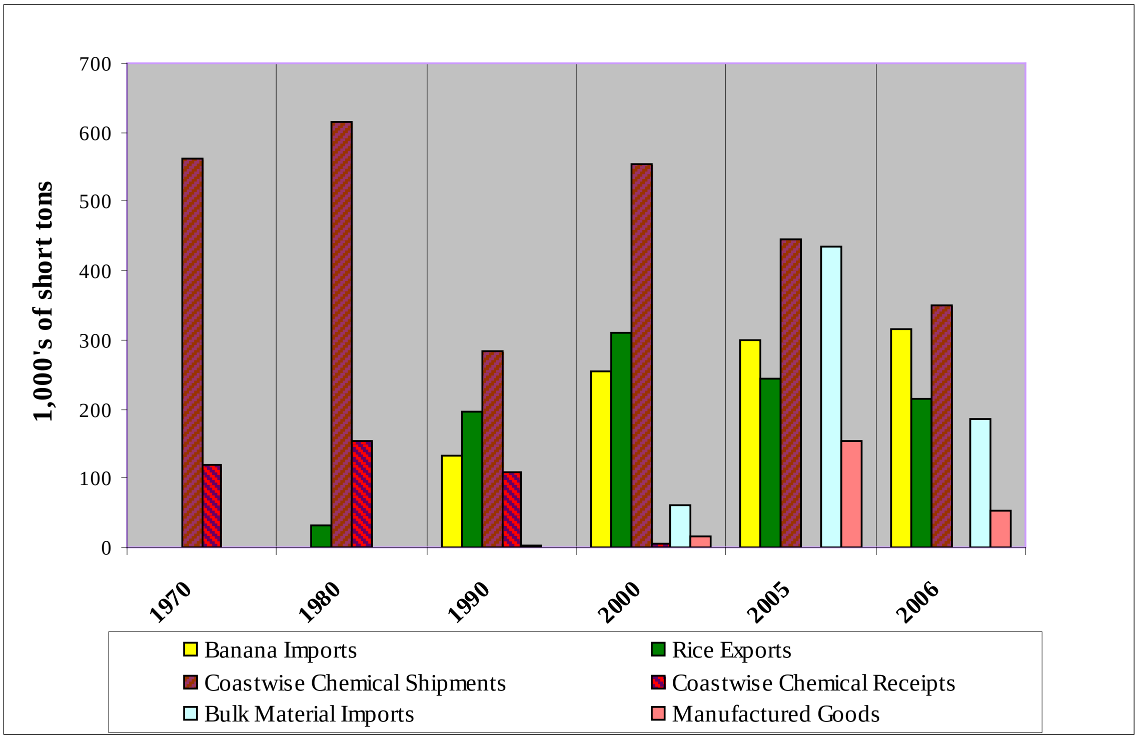
Year	Banana Imports	Rice Exports	Bulk Materials & Manufactured Goods	Coastwise Chemicals		Group Total	Total Ocean-going Tonnage	% of Total Ocean--going Tonnage
				Receipts	Shipments*			
1970	0	0	1	118	563	682	2,291	30
1975	0	100	18	130	537	784	5,482	14
1980	0	32	1	154	614	801	17,299	5
1985	203	24	1	158	217	602	10,319	6
1990	133	195	4	109	284	725	10,164	7
1995	174	287	8	62	380	911	14,922	6
1996	202	247	12	41	344	846	19,880	4
1997	133	212	8	71	527	951	21,849	4
1998	320	175	5	86	426	1,012	24,552	4
1999	301	174	11	82	428	996	23,225	4
2000	255	310	76	6	555	1,202	26,150	5
2001	173	210	160	10	533	1,086	25,498	4
2002	293	226	47	0	419	985	22,563	4
2003	233	210	89	0	443	975	25,612	4
2004	237	203	504	0	712	1,656	29,116	6
2005	300	245	591	1	445	1,582	28,930	5
2006	315	215	240	0	350	1,120	27,571	4
2007	354	101	405	0	281	1,141	24,065	5

Source: USACE, Waterborne Commerce of the U.S., Part 2, 1970–2007.
*Primarily consists of shipments of hydrocarbons.

refrigerated cargo vessels. Future use of larger vessels for banana imports is not anticipated. The deadweight tonnage (DWT) range for refrigerated cargo vessels is 11,000 to 16,000. Analysis for the fleet showed that the median beam width of the future is not expected to increase.

While it does not appear that refrigerated cargo vessel sizes are increasing, significant increases are occurring for other vessel groups, and completion of the Panama Canal expansion by the year 2014 will allow for more-fully loaded vessel movements from deepwater ports in the Far East and the western coasts of Mexico and South America. The canal expansion will accommodate maximum loaded drafts of 15 meters, or approximately 49 feet. Freeport's increasing traffic volumes and vessel size limitations within Brazos Harbor Turning Basin for general and container cargo facilities (Figure 5) prompted construction of landside facilities adjacent to the Upper Turning Basin and lower reach of the Stauffer Channel.

Figure 4
Freeport Harbor 1970–2006
Other Ocean-going Cargo
(1,000s of Short Tons)



Source: USACE, Waterborne Commerce of the U.S., Part 2, 1970–2006.

Freeport's other general cargo base consists of rice exports and bulk materials. Rice is transported in general cargo vessels, and the size of these vessels has increased over the last decade. The largest general cargo vessels using the public terminal range from 40,000 to 46,000 DWT. The larger carriers are used for meat, sugar, cereal, and vegetable imports from Brazil and Europe. There are some indications of transitions to larger vessels for bulk materials, chemicals, and general cargo. While more deeply loaded vessels are not anticipated for the turning basin reach, the port is expanding general and container cargo facilities just outside the turning basin reach due to capacity constraints within the basin and the introduction of larger container vessels for a wider range of commodities. The Port is constructing a new container facility, Velasco Terminal.

Large bulk carriers are used in the import of Freeport's limestone and building materials. Maximum vessel size is presently 67,000 DWT. Design drafts range from 40 to 44 feet, and loaded drafts range from 35 to 39 feet. Total limestone imports for 2005 were 433,000 tons. Limestone imports represented 40 percent of 2003–2005's general cargo tonnage. Rock and limestone are used in residential and commercial building construction and have increased at all

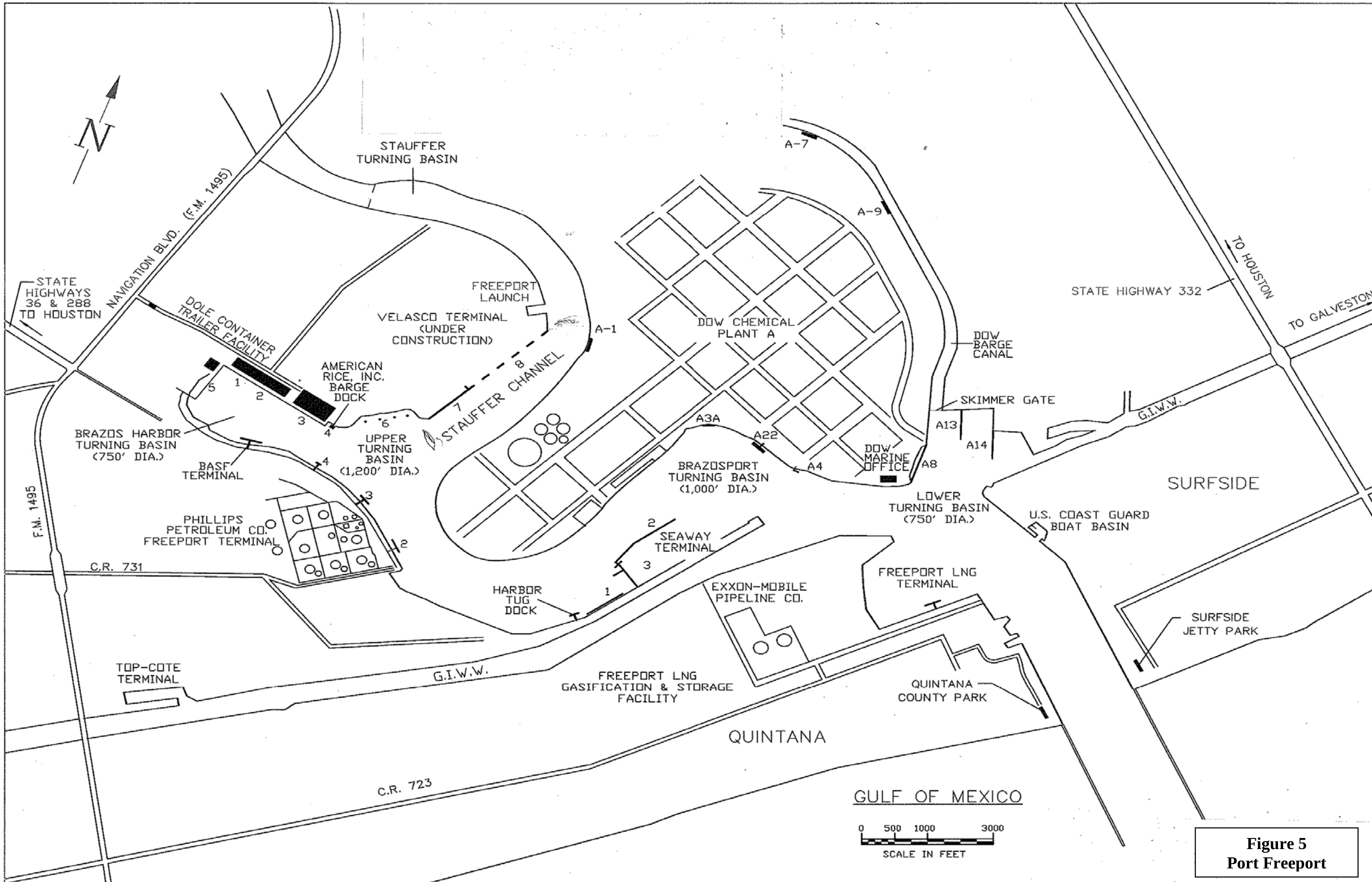


Figure 5
Port Freeport

Note:
This page and the placeholder for Figure 5 before it will be replaced by 11-by-17-inch pages.

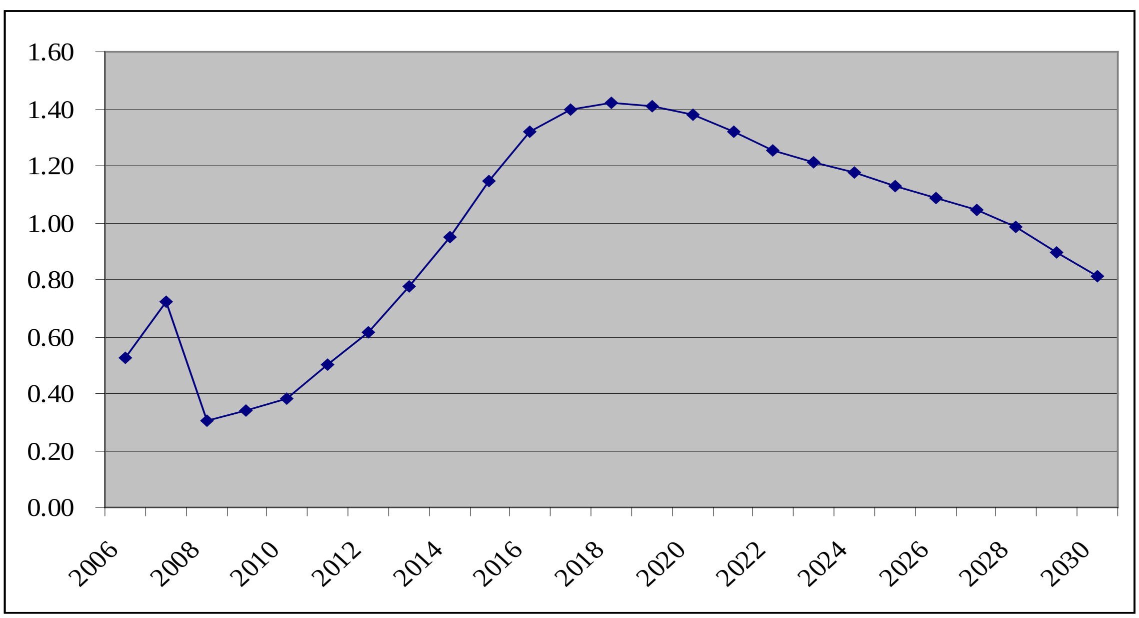
Texas ports. These cargoes are presently transported through the facilities in the Brazos Harbor Basin. A portion of future bulk traffic is anticipated to move to the Velasco Terminal dock. This move will allow for the use of larger and more-fully loaded bulk carriers.

2.1.5 Liquefied Natural Gas Overview

Freeport's LNG terminal became operational in April 2008. The terminal is located along the southern edge of the Freeport Harbor Jetty Channel near Station 65+00 and adjacent to the intersection of the Freeport Harbor Channel and the GIWW. The docks at the LNG terminal were built to accommodate vessels 1,099 feet long by 177 feet wide.

Total U.S. LNG imports were down in 2008 by 54 percent from the 2007 record high of 771 billion cubic feet. While LNG traffic through Freeport is also presently low, the DOE's April 2009 forecast shows U.S. LNG imports reaching 2007 levels again in 2017 and peaking at 1,380 billion cubic feet in 2020. Between 2020 and 2030, imports are forecasted to turn down once again. Figure 6 shows the DOE's 2006–2030 U.S. LNG import forecast. Freeport's existing LNG facility includes two 160,000-cubic-meter (m^3) storage tanks and one piled dock capable of handling LNG vessels in excess of 200,000 m^3, in order to accommodate the largest LNG tankers under construction today. The first phase of the project allows the facility to have a send-out capacity of 1.75 billion cubic feet per day.

Figure 6
U.S. LNG Imports 2006–2030
Trillions of Cubic Feet



Source: U.S. Department of Energy, Updated Annual Energy Outlook 2009 Reference Case Reflecting Provisions of the American Recovery and Reinvestment Act and Recent Changes in the Economic Outlook, Table 13, SR/OIAF/2009-03.Container Overview

Natural gas will be transported from Freeport through a 9.4-mile pipeline to Stratton Ridge, Texas, which is a major point of interconnection with the Texas intrastate gas pipeline system. The Freeport Section 204 widening analysis includes detailed analysis of Freeport's LNG market. Import volumes of 84.2 billion cubic feet per day are forecasted for 2010, with volumes increasing to 712 billion cubic feet by 2018 as shown in the Section 204 report. The vessel sizes and expected throughput prompted the non-Federal sponsor to pursue widening of the Outer Bar and Jetty channels from 400 to 600 feet under the Section 204 authority of WRDA of 1986, as amended in 1990. Phase I of the terminal is presently in operation, and vessel traffic commenced in April 2008. While LNG provided the impetus for the Section 204 study, channel widening would also benefit existing and future traffic. The base analysis used for the feasibility study assumes that the channel is widened.

2.1.6 Container Overview

The Stauffer Channel (upstream of the Upper Turning Basin) presently has an operating depth of approximately 18 feet. The channel was authorized to 30 feet and had an operating depth of 25 feet in the mid-1950s. In 1955, the channel was placed in an inactive status and subsequently deauthorized in 1974 under Section 12, Appendix C, PL 93-251. Since its deauthorization, the channel depth has deteriorated from its previously constructed 25 feet to an approximate 18-foot water depth. The depth limitations and impediments associated with silting generate safety concerns and contribute to declining utilization patterns.

2.1.6.1 Stauffer Channel Modification

In order to accommodate a container facility, the port initially wished to extend the terminus of the Federal channel to include a portion of the Stauffer Channel. The length of the proposed channel was to be approximately 1,200 feet from the federally authorized 45-foot-deep Upper Turning Basin. The port presently ships and receives general cargo through the Brazos Harbor Turning Basin docks. As part of the feasibility study, optimization of the depth for the channel modification would need to be determined. Depth alternatives of 35, 40, 45, and 50 feet were initially evaluated for the 1,200-foot reach. The results of the initial screening resulted in a more-focused evaluation of a smaller range of depths, as discussed in Section 5. Analysis was conducted to determine the competitive advantage that Freeport might potentially have over competing ports. For instance, there is considerable overlap between the Houston and Freeport population centers, and a Freeport container terminal has the potential of capturing associated savings.

2.1.6.2 Stauffer Channel Container Cargo

The proposed Freeport container facility would be in competition with the Port of Houston facilities, specifically Barbours Cut, as well as the facilities at Bayport (Houston) and at the planned facility at Shoal Point in Texas City. Barbours Cut is the Gulf Coast's largest container facility and is the third largest in the Nation. Therefore, the Houston fleet was reviewed as a potential indicator of vessel size expectations.

2.1.7 Offshore Vessel Overview

Presently the upper reach of the Stauffer Channel from Station 223+00 through Station 256+00 has a water depth of approximately 18 feet. In spite of its deauthorization, the Stauffer Channel is used to a limited extent. Prior to its deauthorization in 1974, the project operating depth was 25 feet. Channel user traffic consists of seismic and crew vessels. Discussions with channel users and company officials indicated that maneuvering between the silted channels and maintaining a proper alignment for safe passage is difficult. The difficulty results from under-hull clearance that the pilots need for safety. Clearance needs to be approximately 10 percent of the channel depth.

2.2 SAFETY AND NATIONAL SECURITY

In light of recent world events, global concern regarding acts of international terrorism and organized crime has increased, leading to heightened domestic and international security at U.S. ports. Efforts led by the U.S. Customs Service, USCG, and World Customs Organization have increased port security by requiring more-stringent vessel inspections, deploying additional monitoring vessels, and increasing terminal owner/operator security measures. Programs such as Operation Noble Eagle, Operation Neptune Shield, and additional Homeland Security concepts and strategies have been integrated into the daily operations of ports through coordination of USCG resources and partnerships with the maritime community and local law enforcement agencies. These partnerships are working to increase the local network of and interaction among Federal, State, and local law enforcement and intelligence agencies. Port Freeport operates under very strict safety policies and measures, which are for the most part beyond the scope of this study.

Port Freeport is one of the Nation’s most important ports for the petrochemical industry. Key national influences include TEPPCO Terminal, Dow Chemical, Freeport LNG, BASF Corporation, and the Strategic Petroleum Reserve (SPR). A deeper and wider channel that allows for safer and more-efficient movement of crude and petroleum products is not only an economic benefit to the U.S., but also makes the channel safer for ship traffic and brings the U.S. a step closer to being more self-sufficient in the refining of fossil fuels. This can ultimately contribute to our national security. Improvements to navigation and the continued cooperation between international and national agencies and the private business sector contribute to the security of our Nation and its ports.

2.3 ENVIRONMENTAL

The potential impacts of the proposed project on human and environmental resources were identified during the public interest review, including the placement of dredged material. All factors that may be relevant to the proposed project were considered, including the following: dredged material management, air quality, shoreline erosion, economics, historic resources, protected species, ecological resources, water and sediment quality, geology and soils, energy needs, hazardous materials, recreation, and, in general, the welfare of the people. Air quality impacts resulting in nitrogen oxides (NO_x) increases and displacement of ephemeral wetlands and riparian forest at proposed upland PAs have been addressed in the project FEIS.

2.4 PROBLEM SUMMARY

The depth and width of the existing channel system remain restrictive to a large portion of the current world fleet because of their size. Beam width restrictions continue to cause delays for larger ships wishing to enter Freeport's port facilities. Increased channel depths would reduce the need for lightering and lightening. Access to additional facilities would also allow the Port of Freeport to utilize facilities for future development. A project addressing current shipping delays while increasing safety for both the industry and the environment is needed.

3.0 FORMULATION OBJECTIVES, CONSTRAINTS, AND CRITERIA

3.1 NATIONAL OBJECTIVES

The fundamental national objective of Federal participation in water resources development projects is to assure that an optimum contribution is made to the welfare of all people. The Water Resources Council's *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* dated March 1983 and the National Environmental Policy Act of 1969 (NEPA), PL 91-190, as amended, provide the basis for Federal policy for planning Federal water resources projects. These authorities have established the procedures for formulation and evaluation of water resources projects. Additional policies and regulations, derived from executive and legislative authority, further define the criteria for assessment of plan impacts, risk analysis, review and coordination procedures, and project implementation.

Current Federal policy dictates that National Economic Development (NED) is the primary national objective in water resources planning. NED objectives stress increasing the value of the Nation’s output of goods and services and improving economic efficiency on a national level. Planning objectives designed to improve NED are concerned with the value of increased output of goods and services resulting from external economics associated with a plan.

The Federal objective of water and related land resources planning is to contribute to NED in a manner that is consistent with protecting the Nation's environment. Consequently, the resource's condition should be more desirable with the recommended plan than under the without-project condition.

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

Four accounts are established to facilitate display of effects of alternative plans. The NED account is required. Other information that is required by law or that will have a material bearing on the decision-making process should be included in the other accounts, or in some other appropriate format used to organize information on effects:

1. The NED account displays changes in the economic value of the national output of goods and services;
2. The environmental quality (EQ) account displays nonmonetary effects on significant natural and cultural resources;

3. The regional economic development (RED) account registers changes in the distribution of regional economic activity that results from each alternative plan. Evaluation of regional effects are to be carried out using nationally consistent projections of income, employment, output, and population; and
4. The other social effects (OSE) account registers plan effects from perspectives that are relevant to the planning process, but are not reflected in the other three accounts.

3.1.1 Regional Sediment Management

Regional sediment management was also a considered objective. Section 2037 of WRDA 07 amends Section 204 of WRDA 92. The objective was to investigate the opportunity to develop, at Federal expense, a regional sediment management plan, in cooperation with appropriate Federal, State, regional, and local agencies, for sediment obtained through construction, operation, or maintenance of an authorized Federal water resources project. The regional sediment management plan would identify projects for transportation and placement of sediment to reduce storm damages to property and protect, restore, and create aquatic and biologically related habitat including wetlands.

3.2 PLANNING OBJECTIVES

The primary objective of Federal navigation activities is to contribute to the Nation's economy while protecting the Nation's environmental resources in accordance with existing laws, regulation, and executive orders. More-specific planning objectives were identified by area residents and concerned State and Federal agencies or suggested by existing opportunities for improving the quality of life. Plans were formulated and evaluated with the following objectives in mind:

1. To improve the navigational efficiency and safety of the deep-draft navigation system at Freeport Harbor within the period of analysis, and
2. To maintain, protect, or restore the quality of the Freeport Harbor area's terrestrial, cultural, estuarine, and coastal resources within the period of analysis.

3.3 PLANNING CONSTRAINTS

Plans must be formulated with regard to addressing the problems and needs of the area, taking into consideration future without-project (FWOP) conditions. The plans should identify tangible and intangible benefits and costs from economic, environmental, social, and regional perspectives. Institutional implementation constraints should also be identified. The formulation framework requires the systematic preparation and evaluation of alternative solutions to the recognized water resource–related problems within the study area. The process also requires that impacts of the proposed action be measured and results displayed or accounted for in terms of contributions to NED, EQ, RED, and OSE.

Interaction with other interests must be maintained throughout the planning process to avoid duplication of effort, minimize conflicts, obtain consistency, and assure completeness. The following constraints apply to this feasibility study:

- Fish and wildlife habitat in the study area should be preserved, if possible;
- The study process and plans developed must comply with Federal laws and policies; and
- Alternative plans that resolve problems in one area should not create or amplify problems in other areas.

3.4 PHYSICAL CONSTRAINTS

Plans must be formulated with regard to addressing physical channel constraints in two areas. Widening in the Jetty Channel area will be limited to a top width based on the distance between the jetties. Relocation of the jetties could make the project economically infeasible. The second area with physical constraint issues is in the channel reach between the Brazosport Turning Basin and the Upper Turning Basin. Within this reach, there are dock facilities whose modifications could make channel widening economically infeasible.

3.5 GUIDANCE AND CRITERIA

Current guidance specifies that the Federal objective of planning is to contribute to NED consistent with protecting the Nation's environment. The following general criteria are applicable to all water resource studies. They have generally guided the formulation of this study. Technical, economic, environmental, and social criteria have been established to guide the project development process. These criteria are discussed below.

3.5.1 Technical Criteria

Technical criteria require the preservation of adequate project dimensions to provide safe passage of commercial navigation traffic through this waterway while minimizing environmental impacts. These criteria require plans to be compatible with navigation needs and consistent with the requirements of the navigational equipment using this portion of the waterway and to provide a long-term plan for the placement of dredged materials in order to continue maintenance of the waterway in the future. These plans must be consistent with specific environmental conditions of the area including soil conditions, topography, and terrestrial and aquatic ecosystems.

Formulation of alternative alignments and dredged material placement alternatives and their evaluation was accomplished by analysis of historical and projected shoaling rates, erosion causes and rates, and general structural and nonstructural alternatives applicable for conditions that are specific to this area. Technical information, both historical data and specific information prepared for this project, used during this study included, but was not limited to, ship simulation results, aerial photography, historical dredging records, and previously published scientific reports related to this area.

3.5.2 Economic Criteria

The economic criteria require that tangible benefits attributable to projects exceed project costs. Project benefits and costs are reduced to average annual equivalent values and related in a ratio of benefits to costs (benefits-to-cost ratio, or BCR). This ratio must exceed unity to meet the NED objective. Selected plans, whether structural, nonstructural, or a combination of both, should maximize excess benefits over costs; however, unquantifiable features must be addressed subjectively. These criteria are used to develop plans that achieve the objective of NED and provide a base condition for consideration of economically unquantifiable factors that may impact on project proposals.

All structural and nonstructural measures for navigation projects should be evaluated using the appropriate period of analysis and the currently applicable interest rate. Total annual costs should include amounts for operation, maintenance, major replacements, and mitigation, as well as amortization and interest on the investment.

3.5.3 Environmental Criteria

The general environmental criteria for navigation projects are identified in Federal environmental statutes, executive orders, planning guidelines, and the Environmental Operating Principles (EOP). It is the national policy that fish and wildlife resource conservation be given equal consideration with other study purposes in the formulation and evaluation of alternative plans. The basic guidance during planning studies is to assure that care is taken to preserve and protect significant ecological and cultural values, and to conserve natural resources. These efforts also should provide the means to maintain and restore, as applicable, the desirable qualities of the human and natural environment. Alternative plans formulated to improve navigation should avoid damaging the environment to the extent practicable and contain measures to minimize or mitigate unavoidable environmental damages. Particular emphasis was placed on the following:

- Protection, preservation, and improvement of the existing fish and wildlife resources along with the protection and preservation of estuaries and wetland habitats and water quality;
- Consideration in the project design of the least-disruptive construction techniques and methods;
- Mitigation for project-related unavoidable impacts by minimizing, rectifying, reducing or eliminating, compensating, replacing, or substituting resources;
- Preservation of significant historical and archeological resources through avoidance of impacts. This is the preferable action to any other form of mitigation since these are finite, nonrenewable resources.

EOP have been established for evaluation of water resource projects. Throughout the study process, the EOP should be considered. The EOP ensure conservation, environmental preservation, and restorations are considered at the same level as economic issues. These principles are (1) strive to achieve environmental sustainability, (2) consider environmental consequences, (3) seek balance and synergy, (4) accept responsibility, (5) mitigate impacts, (6) understand the environment, and (7) respect other views.

3.5.4 Social and Other Criteria

Plans proposed for implementation should have an overall favorable impact on the social wellbeing of affected interests and have overall public acceptance. 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.

3.5.5 Other USACE Initiatives

3.5.5.1 USACE Campaign Plan

In August 2006, as a result of lessons learned from hurricanes Katrina and Rita, the USACE Chief of Engineers initiated the "Actions for Change" in an effort to transform the USACE planning, design, construction, and operation and maintenance (O&M) principles and decision-making processes. This program has been further developed into the Campaign Plan. The USACE is moving forward with this Campaign Plan to transform the way business is done. The USACE Campaign Plan is available on the internet at http://www.usace.army.mil/about/campaignplan/ Pages/Home.aspx.

The successful achievement of the goals and objectives contained in this Campaign Plan are dependent on actions implemented by the entire USACE team. The Campaign Plan included four goals for USACE. These goals are:

Goal 1: Ready for all Contingencies – Deliver USACE support to combat, stability, and disaster operations through forward deployed and reachback capabilities.

Goal 2: Engineering Sustainable Water Resources – Deliver enduring and essential water resource solutions through collaboration with partners and stakeholders.

Goal 3: Delivering Effective, Resilient, Sustainable Solutions – Deliver innovative, resilient, sustainable solutions to the Armed Forces and the Nation.

Goal 4: Recruit and Retain Strong Teams – Build and cultivate a competent, disciplined, and resilient team equipped to deliver high quality solutions.

Goals 1 and 4 do not apply directly to the USACE planning process and are not discussed in detail. Goals 2 and 3 pertain to water resources planning and directly to the Freeport Harbor study. These goals are described in more detail below.

Goal 2: Engineering Sustainable Water Resources

With Goal 2 USACE focuses on comprehensive, sustainable, and integrated solutions to the Nation's water resources challenges through collaboration with stakeholders. This goal refers to not only developing and delivering comprehensive and lasting solutions but also ensuring that these solutions are long lasting, integrated, and holistic to respond to today's and future challenges.

Goal 3: Delivering Effective, Resilient, Sustainable Solutions

Goal 3 emphasizes that USACE will provide innovative, resilient, and sustainable infrastructure solutions for the Nation today and in the future. USACE is the Nation's premier public service engineering and construction organization and can provide infrastructure support to serve both the military and national civilian arenas. This effort will improve resilience and lifecycle investment in critical infrastructure, deliver reliable infrastructure using a risk-informed asset management strategy, and develop and apply innovative approaches to delivering quality infrastructure.

The Campaign Plan results are discussed in Section 12.

4.0 PLAN FORMULATION

4.1 PLAN FORMULATION RATIONALE

The rationale for formulating and developing alternative solutions is discussed in the following paragraphs. The planning framework requires the systematic preparation and evaluation of alternative ways of addressing problems, needs, concerns, and opportunities while considering environmental factors. The criteria and broad planning objectives previously identified form the basis for subsequent plan formulation, screening, and ultimately plan selection.

The planning process for this study has been driven by the overall objective of developing a comprehensive plan that would allow reliable and efficient ship traffic at Freeport Harbor. Secondary objectives have been to address other related water resources problems in the study area. The first phase of this process was to establish the magnitude and extent of the problems and then to develop and evaluate an array of alternative solutions to meet the existing and long-range future needs of the area.

During the feasibility phase, lines of communication were opened with Federal, State, and local agencies, private groups, and the affected public. Through scoping and other coordination meetings, public involvement activities were continued throughout the planning process.

The expected FWOP scenario was first developed for comparison with other alternatives. Nonstructural and structural plans were developed to address the planning objectives. For the structural plans, an array of channel modifications and dredged material placement alternatives were developed, evaluated, and screened. The modifications were investigated as to possible means to satisfy the objectives of a more-reliable, more-efficient Freeport Harbor.

Through a two-phased screening process, a plan was ultimately selected. The first phase of plan formulation was the initial assessment of potential management measures with initial technical and environmental criteria. Rough cost and economic estimates were made for potential alternative plans, and the plans were screened. Further preliminary and detailed design refinements were accomplished for the screened alternatives and for the recommended plan prior to developing a baseline cost estimate for this plan.

Structural and nonstructural measures were examined for project applicability. The No Action/Without-Project conditions were established for the project. Preliminary alternatives were developed for various plans. Preliminary environmental considerations were evaluated for the various plans. From these evaluations in Phase 1, alternative plans were selected to carry forward into Phase 2, detailed plan formulation.

Benefits and costs, detailed in Table 6, were developed for preliminary channel alternatives up to the Upper Turning Basin. These numbers were used to reduce the number of alternatives to be considered during more-detailed evaluation. Mitigation was considered to be the same for all alternatives during the screening of alternative plans. Cost factors such as levee construction, dredging, and pipeline relocation/removal, engineering design, and construction management were included in this cost analysis. The evaluation was performed to put all the alternative plans on an equal basis without the mitigation costs. Although no ecological benefits and mitigation costs were calculated, all alternatives were reviewed for potential effects to the environment in a nonquantitative manner. Costs for O&M for each of the alternatives were not included in the initial evaluation but were considered in the later screening process. Costs were developed for all of the alternative plans; however, benefits were determined only for traffic associated with terminals on the authorized channel. Benefits for the Stauffer Channel were not calculated for the initial screening.

Table 6
Initial Costs and Benefits for Considered Alternatives

Freeport Harbor Channel Widening and Deepening					
Depth (feet)	**Width (feet)**	**Benefits ($000)**	**Cost ($000)**	**BCR**	**Net Benefits ($000)**
45	500	650	1,024	0.6	–374
48	400	37,855	6,567	5.8	31,288
48	470	–	7,519	–	*
48	500	38,505	7,821	4.9	30,683
48	530	–	8,056	–	*
50	400	49,758	7,834	6.4	41,924
50	470	–	8,847	–	*
50	500	50,408	9,075	5.6	41,333
50	530	–	9,375	–	*
52	400	60,483	9,168	6.6	51,316
52	470	–	10,248	–	*
52	500	61,133	10,553	5.8	50,581
52	530	–	11,088	–	*
55	400	90,300	13,179	6.8	77,121
55	470	–	14,411	–	*
55	500	91300	15,424	5.9	75,876
55	530	–	16,121	–	*
60	400	140,000	20,280	6.9	119,720
60	470	–	21,778	–	*
60	500	141,474	23,591	6.0	117,883
60	530	–	24,340	–	*

*Benefits were not computed for these widths because the ship simulation study was used to determine the preferred width of the channel. It was not necessary to compute a BCR for each depth and width combination, but only to determine the best depth alternative for a common width.

Environmental concerns identified during the reconnaissance study in 2002 included the potential for environmental harm resulting from shipping accidents and associated oil/chemical spills, or other harmful releases to the environment. Safety issues and vessel casualties were reviewed. The results of these investigations indicated that differences between without- and with-project future casualty occurrences were generally not discernible. Vessel accident risks are presently minimized by the BRPA traffic rules. Minimization of accident probability through traffic rules will continue under the without- and with-project future conditions. The transit/traffic rules and associated restrictions are voluntary and agreed upon by the shipping industry, supported by the USCG Captain of the Port Orders under the Ports and Waterways Safety Act of 1976, as amended, and administered by the BRPA. The agreement dated January 12, 1981, will remain in force until the shipping industries, BRPA, and USCG agree to its revision or modification. Freeport Channel vessel traffic, particularly crude petroleum tankers and product tankers, are subject to vessel size limitations due to the existing 400-foot channel width. While traffic rules would be relaxed to some extent based on channel widening performed under the non-Federal sponsor's Section 204 study, the rules will be designed to limit risk. The Section 204 project will result in an increase in channel width from 400 to 600 feet.

Sediment quality in Freeport Harbor is not a concern for any alternative plan considered.

4.2 NO ACTION AND FUTURE WITHOUT-PROJECT CONDITION

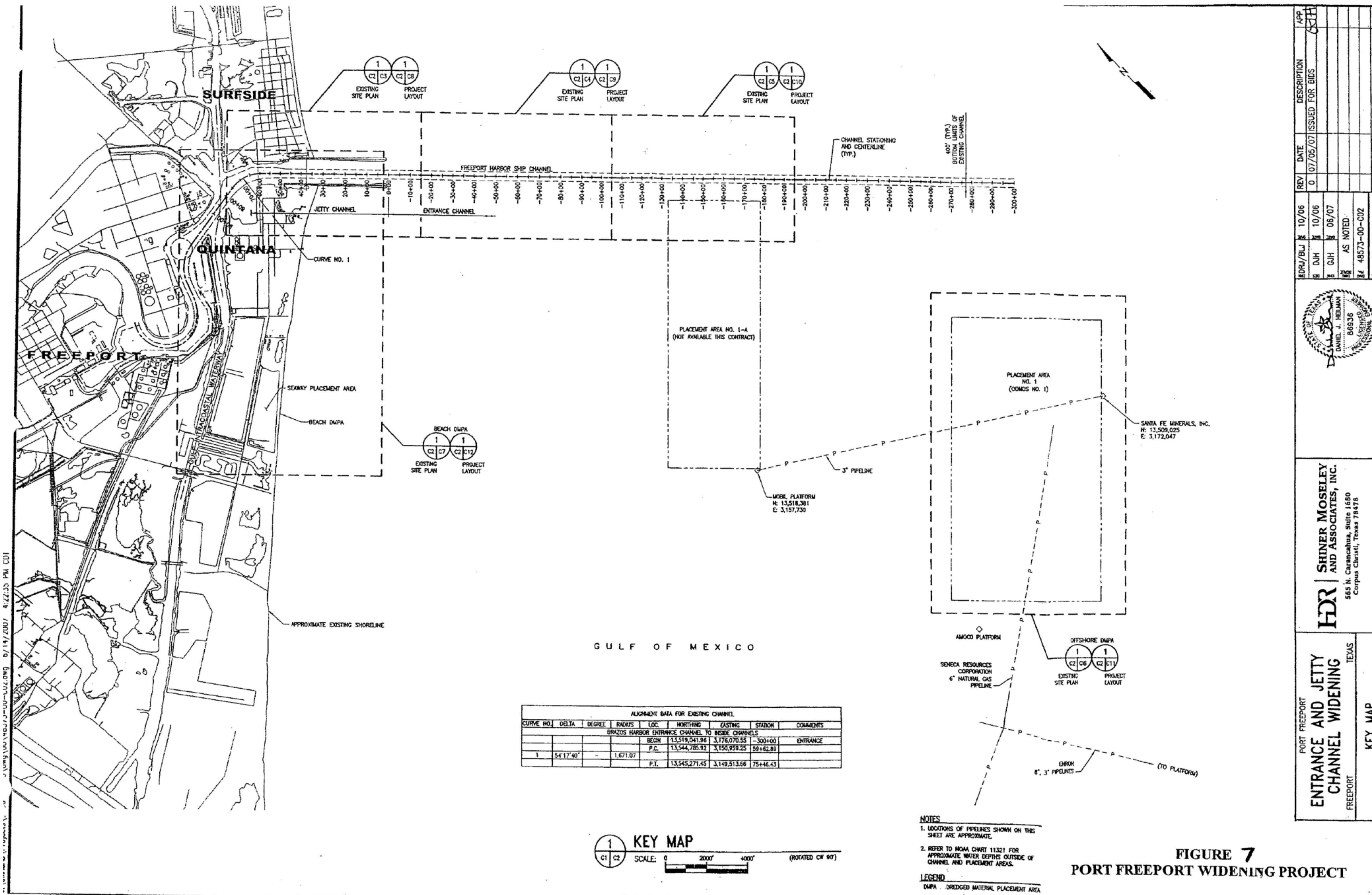
To comply with the requirements of NEPA, a "No Action" Alternative must be included in the alternative array. The USACE planning guidance also requires analysis of a FWOP plan as one of the alternatives. The No Action Alternative describes existing conditions in the project area and is normally used for establishing FWOP conditions for an existing project. That is, FWOP conditions are those conditions that would normally occur due to natural or human-induced changes in the environment, changes in socioeconomic conditions, or other changes at some future point in time that would modify or influence an existing project, in the absence of a specific Federal action. As such, the No Action Alternative normally provides the basis for establishing the FWOP, and is used for comparative purposes when assessing impacts of other proposed alternatives. The No Action Plan consists of a 45-foot-deep by 400-foot-wide navigation channel with its periodic maintenance dredging program. Use of the channel by multiple vessels would be limited because of the current 400-foot width of the channel. As vessels increase in draft and beam, the restrictive depth and width of Freeport Harbor would prevent some vessels from entering with full loads, or would prevent the use of the channel complex altogether by large vessels. The need to lighter products and/or light load vessels would increase, thereby increasing overall user costs and decreasing the efficiency of the vessels using the waterway.

However, in the case of the proposed Federal project, the primary FWOP condition will not be based on the existing No Action Alternative. Instead, it will be based on proposed modifications of the existing channel under a permit widening application submitted to the USACE, Galveston District by the non-Federal sponsor (Port Freeport) subsequent to initial plan formulation. Under the permit widening action, the existing Outer Bar and Jetty channels would be widened, but not deepened. The FWOP condition would consist of the existing 45-foot-deep Outer Bar Channel, which would be widened from 400 to 600 feet. The permit action proposed by Port Freeport is within the footprint of the proposed Federal project. The permit site is located along the northern edge of the Outer Bar and Jetty channels. The permit was issued in March 2009, and the permit Widening Project would be constructed ahead of the proposed Federal project. Widening construction would begin upon approval by the Assistant Secretary of the Army (Civil Works) (ASA(CW)) for Federal assumption of maintenance expected in 2013. The Port Freeport Widening Project is shown on Figure 7.

The non-Federal study investigated the feasibility of widening the Outer Bar and Jetty channels by non-Federal interests at no cost to the Federal government, and then having the Federal government assume the maintenance responsibility of the widened increment. The authority to conduct the study is granted by Section 204(f) of WRDA 86, as amended in 1990. If the study determines that widening is economically justified, environmentally acceptable, and complies with Federal law and plan formulation guidance, the same section grants the ASA(CW) authority to approve assumption of such maintenance as part of the Federal project.

The purpose of the proposed non-Federal permit is to widen the channel to eliminate existing operational constraints that include (a) one-way traffic, (b) daylight-only operations for larger vessels, and (c) environmental restrictions (crosscurrents) that do not allow larger vessels to enter the port. Eliminating these operational constraints will allow vessels to avoid delays, thereby reducing shipping costs and logistical problems, improving vessel safety margins, and increasing Port Freeport's ability to accommodate more vessel traffic. The existing restrictions on vessel dimensions and port entry conditions are based solely on the existing dimensions of the Federal channel. A ship simulation study was performed for the non-Federal study, and it was identified that the 600-foot alternative was the minimum project width (400- and 500-foot alternatives were also studied) that will meet the stated goal.

An economic benefits analysis was prepared for the proposed permit project. The study assessed the cost and benefits of 400-, 500-, and 600-foot-wide alternatives. The analysis concluded that the 600-foot-wide alternative had the highest net annual benefits and identified the 600-foot alternative as the NED Plan for Section 204(f) purposes, based on the physical constraints of jetty width.



ALIGNMENT DATA FOR EXISTING CHANNEL								
CURVE NO.	DELTA	DEGREE	RADIUS	LOC.	NORTHING	EASTING	STATION	COMMENTS
BRAZOS HARBOR ENTRANCE CHANNEL TO INSIDE CHANNELS								
				BEGIN	13,519,041.96	3,176,070.55	−300+00	ENTRANCE
				P.C.	13,544,785.92	3,150,959.25	59+62.89	
1	54°17'40"	-	1,671.07					
				P.T.	13,545,271.45	3,149,513.66	75+46.43	

NOTES
1. LOCATIONS OF PIPELINES SHOWN ON THIS SHEET ARE APPROXIMATE.
2. REFER TO NOAA CHART 11321 FOR APPROXIMATE WATER DEPTHS OUTSIDE OF CHANNEL AND PLACEMENT AREAS.

LEGEND
DMPA DREDGED MATERIAL PLACEMENT AREA

FIGURE 7
PORT FREEPORT WIDENING PROJECT

Note:
This page and the placeholder for Figure 7 before it will be replaced by 11-by-17-inch pages.

The environmental, engineering, navigation, and economic analyses also identified the 600-foot project as the preferred alternative. By means of the study, Port Freeport is requesting the Federal assumption of O&M of the widened channel increment. Port Freeport is incurring the cost of the widening feasibility study and the cost of the initial widening.

Scenario analyses addressing the risk and uncertainty of the channel widening by the non-Federal sponsor were performed. Two FWOP conditions were ultimately analyzed during detail plan formulation. FWOP-1 assumed the permit (Section 204(f)) action would be constructed; FWOP-2 (No Action) assumed that the permit action would not be constructed. The FWOP-2 scenario was developed at the request of USACE Headquarters (HQ).

4.2.1 FWOP-1

FWOP-1 assumes that construction of the Widening Project would occur before Federal construction of the Freeport Harbor Channel Improvement Project. Under FWOP-1, all channels and turning basins would be maintained at the currently authorized depth of 45 feet, with construction of the permitted 600-foot widening of the Entrance Channel. The widening project is expected to result in approximately 3.2 million cubic yards (mcy) of new work dredged material of which approximately 300,000 cubic yards (cy) of sandy/sand material would be placed on Quintana Beach in front of the Seaway PA. Maintenance dredging of existing ship channels and placement of that dredged material would continue as it is currently. The amount of material dredged from the Outer Bar Channel during maintenance cycles is expected to be about 3.3 mcy per year, an increase of about 1 mcy over existing conditions. The amount of material dredged from the remainder of the channel would remain unchanged. As the most probable project future, FWOP-1 is the condition against which all proposed project alternatives are evaluated, rather than the No Action Alternative or FWOP-2.

4.2.2 FWOP-2

The FWOP-2 Alternative is the existing 45-foot project. The 45-foot project depth and width would be maintained throughout the Entrance Channel. The Main Channel, turning basins, and Stauffer Channel dimensions would remain as described in Table 1. Maintenance material would continue to be placed in the existing Maintenance ODMDS for the Entrance Channel, and in PA 1 for the channels inshore of the Jetty Channel. This FWOP-2 scenario assumes that the non-Federal sponsor’s Widening Project (Section 204(f)) would not be built as anticipated.

4.3 MANAGEMENT MEASURES

A management measure is a feature or activity at a site that addresses one or more of the planning objectives. A wide variety of measures is usually considered. These measures are evaluated separately or combined to form alternative plans for evaluation. Initial measures identified for consideration include both nonstructural and structural.

4.3.1 Nonstructural Measures

One nonstructural opportunity available is the continued use of beam width restrictions within the channel. Current pilot rule restrictions prevent two ships from passing in the channel. These rules are agreed upon by the shipping industry, supported by the USCG, and administered by the BRPA. This measure would only maintain current operations, with its increased costs and delays. Another nonstructural measure is use of lightering and lightening vessels. This is another practice already in use and would offer no additional benefits. Therefore, nonstructural alternatives were not considered feasible or did not fully address the problems.

4.3.2 Structural Measures

Structural measures considered include dredging to widen and deepen the existing Freeport Harbor. These measures allow existing ships to more fully utilize the proposed channel. It also allows ships to avoid delays due to the ability to meet more safely in a wider channel. However, dredging creates the need for the placement of dredged material. Any plan considered should ensure that placement alternatives address the needed capacities as well as the need to ensure minimal impacts to the environment.

5.0 PLAN ASSESSMENT AND SCREENING OF INITIAL ALTERNATIVE PLANS

The ultimate objective of the feasibility study is to arrive at a recommended plan after a full range of alternative plans has been analyzed. This involves a comparison between each alternative plan and the FWOP condition consequences, considering economic, environmental, and social impacts.

5.1 SCREENING PROCESS

As mentioned above, there were two nonstructural measures initially considered: continued use of beam width restrictions within the channel and use of lightering and lightening vessels. Both practices are already in use and would offer no additional benefits. Therefore, nonstructural alternatives were not considered feasible, did not fully address the problems, and were eliminated from further consideration.

A general screening process was first used to determine which structural alternative plan would result in the objective of providing reliable and efficient navigation at the least cost while minimizing environmental impacts. The non-Federal sponsor initially expressed a desire for a channel 600 feet wide and 60 feet deep. Preliminarily constraints to widening are in the Jetty Channel and in the channel reach between the Brazosport Turning Basin and the Upper Turning Basin. Multiple alternative plans were evaluated for more-detailed consideration. These initial screening alternative plans (Table 7) included:

- No Action Plan (1).
- Widening of the Outer Bar and Jetty channels only with no deepening (2).
- Deepening to 50, 55, or 60 feet from the Gulf of Mexico to the Upper Turning Basin, with and without widening, and with widening to 500 and 600 feet only through the Jetty Channel (3 and 4).
- Deepening to 40, 42, or 45 feet the Brazos Harbor Channel and Turning Basin, without widening and with widening to 300 feet (5 and 6).
- Reauthorization of Stauffer Channel to 30 feet (7).
- Deepening the lower (3,700-foot) reach of the Stauffer Channel to 36, 40, 42, 45, and 50 feet without widening and with widening to 300 feet (8–10).
- Dredging the upper (remaining 3,400 feet) reach of the Stauffer Channel to its previously authorized 30-foot depth (11).

Table 7
Initial Screening of Project Management Measures

	Initial Screening Measures
1	No Action
2a.	Widening – 500 foot
2b.	Widening – 600 foot
3a.	Deepen – 50 foot
3b.	Deepen – 55 foot
3c.	Deepen – 60 foot
4a.	Deepen/Widen – 50x500
4b.	Deepen/Widen – 50x600
4c.	Deepen/Widen – 55x500
4d.	Deepen/Widen – 55x600
4e.	Deepen/Widen – 60x500
4f.	Deepen/Widen – 60x600
5a.	Deepen Brazos Harbor Channel – 40 foot
5b.	Deepen Brazos Harbor Channel – 42 foot
5c.	Deepen Brazos Harbor Channel – 45 foot
6a.	Deepen/Widen Brazos Harbor Channel – 40x300
6b.	Deepen/Widen Brazos Harbor Channel – 42x300
6c.	Deepen/Widen Brazos Harbor Channel – 45x300
7.	Reauthorization of Stauffer Channel to 30 foot
8a.	Deepen Lower Stauffer Channel – 36 foot
8b.	Deepen Lower Stauffer Channel – 40 foot
8c.	Deepen Lower Stauffer Channel – 42 foot
8d.	Deepen Lower Stauffer Channel – 45 foot
8e.	Deepen Lower Stauffer Channel – 50 foot
9.	Widen Lower Stauffer Channel – 300 foot
10a.	Deepen/Widen Lower Stauffer Channel – 36x300
10b.	Deepen/Widen Lower Stauffer Channel – 40x300
10b.	Deepen/Widen Lower Stauffer Channel – 42x300
10c.	Deepen/Widen Lower Stauffer Channel – 45x300
10d.	Deepen/Widen Lower Stauffer Channel – 50x300
11.	Redredge Upper 3,400 feet of Stauffer Channel to 30 foot

Based on the problems and opportunities identified by the non-Federal sponsor and the public comments received at the public scoping meeting, a variety of alternative plans was identified to address one or more of the planning objectives. Screening of alternative plans focused on whether deepening and widening would be cost effective. The following criteria were used to evaluate and screen the alternative plans:

- Dredging Quantities
- Cultural Resource Concerns
- Construction Costs
- Sponsor's Preferences
- Public Acceptance
- Minimize Environmental Impacts
- Real Estate Issues
- Project Benefits
- Safety Issues

Preliminary benefits and costs were developed in Phase 1 for these alternative plans (see Table 6) and were used to reduce the number of alternative plans considered during more-detailed evaluation. Mitigation was considered to be the same for all alternatives during the screening of alternative plans. Cost factors such as levee construction, dredging, and pipeline relocation/removal, engineering design, and construction management were included in this cost analysis. Although no ecological benefits and mitigation costs were calculated, all alternatives were reviewed for potential effects to the environment in a nonquantitative manner. Costs for O&M for each of the alternatives were not included in the initial evaluation, but were considered in the later screening process. Costs were developed for all of the alternative plans; however, benefits were determined only for traffic associated with terminals on the authorized channel. Benefits for the Stauffer Channel were not calculated for the initial screening.

The channel was divided into its basic reaches, Outer Bar, Jetty, Lower Turning Basin, Channel to Brazosport Turning Basin, Brazosport Turning Basin, Channel to Upper Turning Basin, Upper Turning Basin, Brazos Harbor Channel and Turning Basin, and Stauffer Channel. The various depth and width options were applied to these reaches. In the Channel to Upper Turning Basin reach, there was some width restriction due to docks on both sides of the channel.

Dredged material from the Outer Bar and Jetty channels reach would be placed in ODMDSs by hopper dredges. There are two existing ODMDSs associated with the existing 45-foot project, the New Work ODMDS and the Maintenance ODMDS. Dredged material from the inshore channel reaches would be placed in confined upland PAs by hydraulic pipeline dredging. There are several existing PAs in the vicinity of the channel; however, new PAs would be needed for new work and maintenance material. Port Freeport owns large tracts of land in the area available for use as PAs.

5.2 NAVIGABILITY/WIDTH SCREENING

Ship simulation testing was conducted on the ERDC Ship/Tow Simulator to determine the navigation and safety impacts in the Freeport Harbor channel. The main objective of the study was to determine whether the "design ship" (68,000 DWT – 965 feet by 106 feet wide) could reliably operate within the depth and widths of the proposed channel dimensions. The simulators are "real time," i.e., ship movements on the simulator require the same amount of time as in real life. Environmental forces such as currents, wind, banks, and ship-ship interactions all act upon the vessel during transit. The pilot controls the simulated vessel's engine speed and rudder. The pilot also has radio contact with assist tugs.

Freeport LNG had proposed to construct a new LNG terminal at the southwestern corner of the intersection of the deepwater navigation channel and the GIWW. As part of the initial screening process, a ship maneuvering study was conducted by Waterways Simulation Technology, Inc., at and in coordination with ERDC to test the safety of ship maneuvering and control in Freeport Harbor. Waterways Simulation Technology, Inc., is a private engineering consulting company specializing in navigation studies involving port, harbor, and channel design, systems behavior, ship and/or tow maneuvering simulations, prototype measurements of ship and/or behavior, and hydrodynamic modeling. The study concluded that ships could maneuver safely in and around the new LNG facility. The proposed facility was included in all ship simulation testing. This facility has since been constructed.

Three alternative channel plans were initially developed for ship simulation for Port Freeport. All three plans assumed construction of the proposed LNG facility at Freeport. As a result of this testing, two plans were abandoned for channel improvement based on pilot input and the third was modified into two alternate plans and evaluated. The results of the ship simulation determined that the Outer Bar and Jetty channels should be 600 feet wide to allow safe operation of the design vessel.

Plan 1 proposed a 62-foot Outer Bar Channel and a 60-foot channel from the western end of the jetties to the Upper Turning Basin. Plan 1 also included deepening of a portion of the Stauffer Channel to the Turning Basin to 50 feet. The Plan 1 Outer Bar Channel is 600 feet wide. The Outer Bar Channel extended the Federal channel by approximately 3 miles into the Gulf of Mexico to the 60-foot contour. Plan 1 included a 1,350-foot turning basin at Brazosport.

Plan 2 proposed a 62-foot Outer Bar Channel and 60-foot channel from the western end of the jetties to the Upper Turning Basin. Plans 1 and 2 were identical inland from the western end of the Brazosport Turning Basin. The Plan 2 Outer Bar Channel was 500 feet wide. Plan 2 included a 1,100-foot turning basin at Brazosport.

Plan 3 would not deepen the existing channels. The proposed Outer Bar Channel was 600 feet wide.

As a result of testing at ERDC, Plans 2 and 3 were abandoned and Plan 3 was modified into Plans 4 and 5. Plan 4 was very similar to the Plan 1 channels with deepening in the same manner and a constant width of 600 feet. Plan 4 also had a 1,200-foot turning basin at Brazosport.

However, the area northwest of the turning basin was dredged to 60 feet to allow more area for turning maneuvers needed by the very large crude carriers (VLCCs) and 165,000 DWT LNG tankers.

Plan 5 varied only slightly from Plan 4 in that the Brazosport Turning Basin was reduced to 1,100 feet in diameter. The area northwest of the turning basin was also dredged to allow for extra area during turning maneuvers as well as serve as a bend widener heading into the area downstream of the Upper Turning Basin.

5.3 SELECTED ALTERNATIVE PLANS

Initial analysis of the Brazos Harbor Channel and Turning Basin, used for general cargo and not used by large, deep-draft vessels, showed that deepening and widening were not justified. No increase in ship size is projected for the users of this area. The 36-foot-deep channel intersects with the Main Channel near Station 170+00, just above ConocoPhillips's petroleum docks. Brazos Harbor Turning Basin vessel traffic primarily consists of refrigerated container vessels delivering bananas and general cargo vessels shipping rice. The configuration of the access area and turning basin limits future expansion opportunities due to the high density of docks and landside facilities. The water and landside limitations of the general cargo reaches prompted development of the adjacent Velasco property for the construction of the new container terminal. The Brazos Harbor Channel was dropped from detailed plan formulation.

From the analysis of the initially considered management measures and with the selection of the preferred width of 600 feet based on the ship simulation study, nine channel alternative plans were selected for further consideration in Phase 2. These channel alternatives included:

No Action Plan – Alternative 1

Gulf to Upper Turning Basin Channel Alternatives:

Alternative 2 – Widen only to 600 feet through the Outer Bar and Jetty channels.

Alternative 3 – Deepen to 50 feet from the Gulf of Mexico to the Upper Turning Basin and widen to 600 feet through the Jetty Channel.

Alternative 4 – Deepen to 55 feet from the Gulf of Mexico to the Upper Turning Basin and widen to 600 feet through the Jetty Channel.

Alternative 5 – Deepen to 60 feet from the Gulf of Mexico to the Upper Turning Basin and widen to 600 feet through the Jetty Channel.

Stauffer Channel Alternatives:

Alternative 6 – Dredge the Stauffer Channel to the previously authorized dimensions of 30 feet deep and 200 feet wide.

Alternative 7 – Widen the lower 3,700 feet of the Stauffer Channel to 300 feet and its previously authorized depth of 30 feet, with the upper 3,400 feet of the Stauffer Channel dredged to previously authorized dimensions of 30 feet deep and 200 feet wide.

Alternative 8 – Widen the lower 3,700 feet of the Stauffer Channel to 300 feet and deepen to 40 feet, with the upper 3,400 feet of the Stauffer Channel dredged to previously authorized dimensions of 30 feet deep and 200 feet wide.

Alternative 9 – Widen the lower 3,700 feet of the Stauffer Channel to 300 feet and deepen to 50 feet, with the upper 3,400 feet of the Stauffer Channel dredged to previously authorized dimensions of 30 feet deep and 200 feet wide.

With the exception of No Action, a detailed analysis of benefits and costs was performed for each of these alternatives. This information is detailed in the following sections 6.0 through 10.0 and was used in selection of the plan.

5.4 ENVIRONMENTAL CONSIDERATIONS ALTERNATIVES

5.4.1 No Action Plan

Under the No Action Plan, the Freeport Harbor project will be maintained at the authorized depth of 45 feet. Shoaled material will be removed and placed in the designated offshore site for the Outer Bar and Jetty channels and in PA 1 for the channel inshore reach of the Jetty Channel. None of the dredged material would be used beneficially. Environmental impacts currently associated with the Freeport Harbor Project would continue.

5.4.2 Future Without-Project Plan (FWOP-1)

Under the FWOP-1, or non-Federal Widening Project, the channel would be maintained at the authorized depth of 45 feet, with a permitted width of 600 feet for the Outer Bar and Jetty channels. The Widening Project is expected to result in approximately 3.2 mcy of new work dredged material, of which approximately 300,000 cy of sandy/sand material would be placed on Quintana Beach in front of the Seaway PA. Maintenance dredging of existing ship channels and placement of that dredged material would continue as it is currently. The amount of material dredged from the Outer Bar and Jetty channels during maintenance cycles is expected to be about 3.3 mcy per year, an increase of about 1 mcy over existing conditions. The amount of material dredged from the remainder of the channel would remain unchanged from current conditions.

5.4.3 Federal Channel Deepening and Widening

Eight channel improvement alternatives were proposed for analysis. All were variations of deepening and/or widening of various reaches or the entire length of the authorized ship channel, as well as an extension of the existing Outer Bar Channel with deepening and widening. The proposed depths for the existing channel ranged from 47 to 60 feet plus advance maintenance and overdepth dredging. Proposed widening would increase the existing project from 400 feet up to 600 feet along most of its length. With two exceptions, none of the alternatives would impact wetlands or upland areas, and all dredging will be confined to open water. However, initial channel widening (from 400 to 600 feet) would be accomplished by the non-Federal sponsor under a permit, ahead of proposed Federal channel improvements. The permit widening would remove approximately 1.9 acres of upland area located near the Jetty Channel just east of the USCG Station on the north (Surfside Beach) side of the channel. Proposed Federal channel improvements (deepening and selective widening) would follow the permit project, producing no additional impacts in the Jetty Channel portion of the permit project area. Alternatives 3 through 9 would impact benthic organisms that would recover rapidly after construction.

During plan formulation, the Federal project considered potential beneficial uses identified by the permit Widening Project such as beach renourishment and marsh restoration using new work dredged material from inland portions of the ship channel. While soil borings indicated some sandy material, no concentrated sand lenses were identified, and the high percentage of clay could not be used for beach nourishment. Marsh restoration was also precluded because of the presence of oysters at two of the three sites considered for restoration. The third potential site was cost prohibitive because of pump distance. New work and maintenance material from the offshore reaches of the ship channel would be placed in existing New Work and Maintenance ODMDSs located along the Outer Bar Channel for all alternatives considered. The EPA has concurred in the use of the existing ODMDSs for proposed new construction and continued project maintenance.

Both new work and maintenance material removed from inland reaches of the ship channel would be placed in existing PA 1 and two proposed new upland PAs, 8 (168 acres) and 9 (250 acres) (see Figure 17 (page 10-2)). The proposed PAs are currently used as pasture for cattle grazing. Construction of the two new upland PAs would impact approximately 21 acres of riparian forest and 39 acres of ephemeral wetlands. Coordination with USFWS and TPWD regarding these impacts has resulted in proposed mitigation that includes creation and maintenance of riparian forest habitat and wetlands.

A terrestrial cultural resource investigation of proposed PAs 8 and 9 located a possible Civil War gun emplacement that will require avoidance or further investigation if avoidance of the site is not possible. Additional cultural resource investigations will be conducted and coordinated under an executed PAg pursuant to 36 CFR 800.

An HTRW assessment was conducted for the project area, including proposed PAs 8 and 9. While several sources of HTRW were identified at upland industries that line the banks of the Freeport Harbor Channel, no active enforcement actions were under way, and no HTRW sites were located within the project area footprint. Previous sediment quality analyses also revealed no contaminant concerns. Therefore, it is unlikely that contaminants will be encountered during construction activities.

6.0 INITIAL ECONOMIC EVALUATION

The project benefits were calculated based on reductions in transportation costs. The initial screening showed that a channel depth of 60 feet produced the highest net excess benefits for the deepening plans evaluated for the Main Channel. The screening analysis suggested that additional studies were necessary to conclude whether widening the Outer Bar Channel was in the Federal interest. The non-Federal sponsor and BRPA expressed a strong interest in widening the Outer Bar Channel reach due to safety concerns and associated vessel delays and self-imposed vessel-meeting restrictions. The recommendation for deepening and widening the Freeport Harbor was based on the ERDC findings and the safety interest of the BRPA. BRPA presently limits vessels greater than 820 feet in length, 145 feet in beam, or having a draft of more than 42 feet. Oversized, excessive-draft, or unusual-type vessels are handled on a “per job” basis with a one-time waiver to the Basic Operating Procedures. Pilots also reserve the right to deny movement of any vessel during times of excessive wind, excessive crosscurrent, or during times of low water.

6.1 GENERAL – INITIAL SCREENING OF SELECTED ALTERNATIVES

This section presents the initial economic benefit analysis for the Freeport Harbor Feasibility Report. The initial project benefits for Freeport Harbor Channel, based only on petroleum, were calculated for a 50-year period of analysis using Economic Guidance Memorandum (EGM) 05-01, Fiscal Year (FY) 05 deep-draft vessel operating costs and FY 05 Federal discount rate of 5.125 percent. In addition to evaluating deepening the existing authorized 45-foot Federal project and widening the Outer Bar and Jetty channels, this analysis presents a discussion of the reauthorization and modification of the Stauffer Channel, which had an authorized channel depth of 30 feet. Depth alternatives between 30 and 50 feet were evaluated for the lower 3,700 feet of the Stauffer Channel. The port anticipates using the channel modification for container cargo. Presently, general cargo is transported through docks located within the 36-foot-deep Brazos Harbor Turning Basin. Deepening the Brazos Harbor Turning Basin, which is part of the federally authorized Freeport Harbor project, was screened out earlier in the study and is not evaluated in this section. The Main Channel leading to the turning basin is 45 feet as is the Upper Turning Basin. The Stauffer Channel, which was deauthorized in 1974, is immediately upstream of the Upper Turning Basin.

For the petroleum benefits presented in the initial analysis, the per ton transportation costs for channel depth alternatives of 50, 55, and 60 feet were compared with the existing 45-foot channel depth costs. For the initial screening, a wide range of depths were examined; 1- to 2-foot increments were evaluated as the study process evolved. The increased channel depths provided improved access to the crude petroleum and petroleum product docks. The non-Federal sponsor was particularly interested in the 60-foot channel depth; therefore, the initial focus of the economic optimization was to determine whether the net excess benefits for depths between 55 and 60 feet increased. Again, the results of the initial analysis helped determine the focus of further detailed analysis. Benefit calculations presented are limited to petroleum. Discussions of other commodities were presented; however, deepening benefits were not estimated. Channel depths of 50 feet and greater could benefit some other commodity groups; however, it was likely that the inclusion of other commodities, as well as containerized cargo, would not affect the plan optimization because the overall volumes of commodities other than petroleum were proportionally small. A benefit estimate for widening of the Outer Bar and Jetty channels was presented. The widening benefits were based exclusively on the transportation savings from using vessels up to 175,000 DWT. Vessels over 120,000 DWT are presently restricted from using Freeport due to crosswinds and the resulting difficulty of navigating the Outer Bar and Jetty channels. The widening benefits were calculated based on the difference between transportation costs for vessels in the 90,000 to 120,000 DWT range versus those associated with vessels in the 90,000 to 175,000 DWT range. The results of the analysis conducted demonstrated a high BCR for widening the existing 45-foot Entrance Channel to 600 feet and for the 60-foot depth.

6.1.1 Benefit Calculations for Petroleum

This section presents the crude petroleum and petroleum product benefit calculations for Freeport Harbor Channel. Channel-deepening benefits for petroleum imports were calculated based on reductions in transportation costs stemming from more-efficient vessel loading of the existing fleet and a higher concentration of larger vessels. The net result of larger loads carried at deeper channel depths is lower per ton transportation costs. The petroleum benefits were estimated based on improved utilization of the existing fleet and a higher concentration of larger vessels. Table 8 presents the FY 05 foreign flag tankers' operating costs used initially for the transportation cost calculations. Table 9 presents Freeport's 2001 and 2003 representative crude oil tankers. Table 10 presents a percentage distribution of 2001 and 2003 crude imports by loaded draft. Table 11 presents representative round-trip mileage for the trade routes or junction points used for the initial transportation savings computations.

In calculating the transportation savings benefits, the without- and with-project transportation costs were initially applied to Freeport's 2001–2002/2003 tonnage. The import projections for crude petroleum and petroleum product were made based on applying the DOE's EIA, published January 2004 reference case growth rates to Freeport's 2000–2002 tonnage. Freeport's 2000–2002 trade route specific base tonnage is presented in Table 12. Table 13 displays transportation savings by channel depths and commodity group. Table 14 presents a summary of the initial project benefits. Also presented are the initial project construction costs, BCRs, and net excess benefits for the 50-, 55-, and 60-foot channel alternatives.

Table 8
Tanker Characteristics and Hourly Operating Cost
Foreign Flag Double-Hull Tankers

DWT	Hourly Operating Cost ($)		
	At Sea	In Port	Base Idle
20,000	947	463	560
25,000	1,008	500	605
35,000	1,135	578	699
50,000	1,292	660	799
60,000	1,460	780	944
70,000	1,552	823	996
80,000	1,644	865	1,047
90,000	1,734	906	1,096
110,000	1,898	971	1,175
150,000	2,216	1,093	1,323
165,000	2,345	1,148	1,389
265,000	3,165	1,475	1,785
300,000	3,436	1,574	1,905
320,000	3,588	1,628	1,970

Source: Application of USACE, Foreign Flag Tanker Costs presented in EGM #11-05, Deep-Draft Vessel Operating Cost May 2011.

Table 9
Freeport Harbor
Crude Petroleum Tankers, 2001 and 2003

DWT Range	2001 Imports short tons	%	Length Overall (LOA)	Beam	Design Draft (feet)	Year Built
<80,000	642,243	3.4	711.83	105.616	40	1986
80,000 to 84,999	1,741,054	9.0	799.71	137.727	40	1986
85,000 to 89,999	1,804,534	9.3	799.83	131.233	43	1985
90,000 to 94,999	3,949,816	20.5	797.93	137.104	45	1995
95,000 to 99,999	4,183,824	21.7	809.64	137.76	44	1993
100,000 to 104,999	393,431	2.0	791.79	137.76	48	1992
105,000 to 109,999	5,854,984	30.3	802.29	137.76	49	1998
110,000 to 114,999	174,397	0.9	818.36	144.32	48	2000
115,000 to 139,999	0	0.0	n/a	n/a	n/a	n/a
140,000 to 155,000	562,305	2.9	898.72	145.753	53	1992
Total	19,306,588	100.0				

Table 9, cont'd

DWT Range	2003 Imports short tons	%	Design Draft (feet)	LOA	Beam	Year Built
<80,000	652,790	3.4	41	748	106	2002
80,000 to 84,999	1,035,962	5.3	40	800	131	1986
85,000 to 89,999	1,120,602	5.7	43	800	138	1990
90,000 to 94,999	1,087,938	5.5	43	810	136	1994
95,000 to 99,999	7,140,817	36.3	45	798	137	1993
100,000 to 104,999	2,141,777	10.9	48	792	138	1992
105,000 to 109,999	5,256,678	26.7	49	797	138	1998
110,000 to 114,999	655,084	3.3	48	817	144	1999
115,000 to 139,999	0	0.0	n/a	n/a	n/a	n/a
140,000 to 155,000	580,101	2.9	53	899	154	1996
Total	19,671,749	100.0				

Table 10
Crude Petroleum Imports, 2001–2003 Average

By Loaded Draft	Percent
≤36	32.2
37	12.5
38	18.5
39	13.4
≥40	23.4
Total	100.0

Table 11
Representative Round-Trip Mileage to Freeport Harbor

From	Miles
Coatzacoalcos, Mexico	1,360
U.S. Gulf Coast Lightering/Lightening Zone	160
Venezuela	3,934
Panama Canal	3,132
Salvador, Brazil	9,606
Rotterdam, Netherlands	10,318
Sture, Norway	11,172
North Africa, Algiers	10,556
West Africa (Nigeria and Angola)	13,030
Persian Gulf and Indian Subcontinent via Suez Canal	19,824
Persian Gulf and Indian Subcontinent via Cape of Good Hope	25,066
Singapore via Panama Canal	24,248
Singapore via Cape of Good Hope	26,304

Table 12
Freeport Harbor Crude Oil Import Tonnage by Trade Route (short tons)

Origin	2000	2001	2002	2000–2002 Average
Mexico	1,068,128	162,723	324,042	518,298
West Indies	169,096	74,442	1,701,232	648,257
Colombia (East)	193,445	277,405	1,051,073	507,308
Ecuador	65,773	1,075,857	85,899	409,176
Venezuela	4,751,039	10,074,779	8,043,919	7,623,246
Brazil	0	106,649	141,989	82,879
North Sea	564,801	86,015	2,110,856	920,558
West Africa	689,671	72,140	1,919,713	893,841
Mideast	94,466	94,855	1,464,172	551,164
Primarily Mideast	12,173,532	7,065,797	1,175,678	6,805,002
Total Tonnage	19,769,951	19,090,662	18,018,573	18,959,729

Table 13
Transportation Savings by Channel Depth and Commodity Group
(1,000s of dollars)

Crude Petroleum Imports						
Transportation Savings by Channel Depth 2010–2060						
	45 w/widening	50	52	55	58	60
2010	2,104.7	7,327.2	9,494.5	13,110	18,401.3	23,793.1
2020	2,704.8	9,195.6	12,049.1	16,524	23,927.3	32,003.2
2030	3,166.0	10,499.8	13,760.3	18,866	27,295.1	36,482.3
2040	3,324.3	11,024.8	14,448.3	19,810	28,659.9	38,306.4
2050	3,490.5	11,576.0	15,170.7	20,800	30,092.9	40,221.7
2060	3,665.1	12,154.8	15,929.2	21,840	31,597.5	42,232.8
Average Annual Benefits (50-Year Period of Analysis at 5.125%)						
	2,788.0	9,411.7	12,305.5	16,897.1	24,305.6	32,284.9
Petroleum Product Import and Export Tonnage						
Transportation Savings by Channel Depth 2010–2060						
	45 w/widening	50	52	55	58	60
2010	0.0	996.8	1,128.9	1,128.9	1,128.9	1,128.9
2020	0.0	1,300.6	1,473.0	1,473.0	1,473.0	1,473.0
2030	0.0	1,664.9	1,885.6	1,885.6	1,885.6	1,885.6
2040	0.0	2,131.3	2,413.7	2,413.7	2,413.7	2,413.7
2050	0.0	2,473.4	2,801.2	2,801.2	2,801.2	2,801.2
2060	0.0	2,870.5	3,250.9	3,250.9	3,250.9	3,250.9
Average Annual Benefits (50-Year Period of Analysis at 5.125%)						
	0.0	1,507.4	1,707.2	1,707.2	1,707.2	1,707.2
Total Benefits by Channel Depth (feet)						
	45 w/widening	50	52	55	58	60
	2,788.0	10,919.2	14,012.7	18,604.3	26,012.8	33,992.1

Table 14
Economic Summary
(1,000s of dollars)

Economic Summary Data	**45 w/widening**	**50**	**55**	**60**
First Cost of Construction ($)	25,766.0	210,808.0	225,344.0	243,085.0
Average Annual Cost ($)	1,493.9	12,222.8	13,065.6	14,094.2
Average Annual O&M* ($)	107.7	680.5	1,242.5	1,609.4
Total Annual Cost ($)	1,601.6	12,903.3	14,308.1	15,703.6
Average Annual Benefits ($)	2,788.0	10,919.1	18,604.3	33,992.1
Net Excess Benefits ($)	1,186.4	–1,984.2	4,296.2	18,288.5
BCR	1.7	0.8	1.3	2.2

*O&M – Operation and Maintenance

6.1.2 Other Cargo

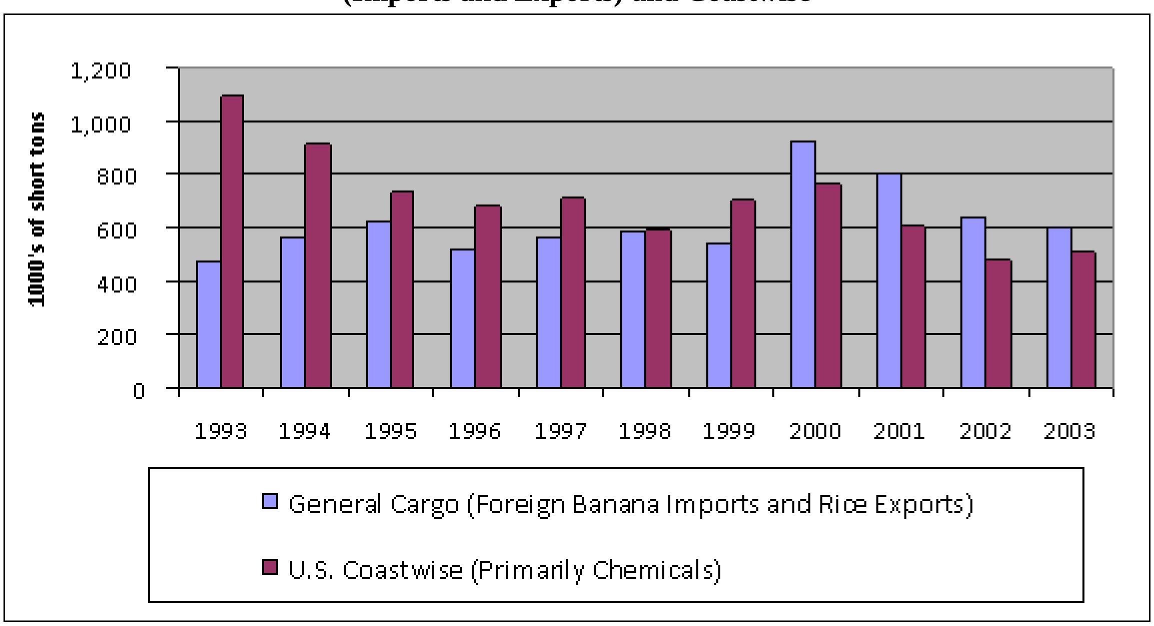
Freeport's remaining cargo primarily consists of banana imports, rice exports, and outbound coastwise chemical shipments. Table 15 presents the 1998–2003 distribution by major group, and Figure 8 displays 1993–2003 cargo trendlines for banana and rice cargoes. Most of the general cargo docks are located adjacent to the Brazos Harbor Turning Basin where the project depth is 36 feet. The Brazos Harbor Channel, leading to the Brazos Harbor Turning Basin, is 36 feet deep.

Table 15
Freeport Harbor General Cargo
Deep-Draft Commodities (1,000s of short tons)
Other Than Petroleum and Chemical Foreign Imports and Exports

Year	Banana Imports	Rice Exports	Limestone & Rock Imports	Coastwise Shipments Chemicals*
1998	320	175	2	589
1999	301	174	3	708
2000	255	310	60	764
2001	173	210	149	604
2002	293	226	33	479
2003	233	210	83	511

*Primarily shipments of hydrocarbons.

Figure 8
Freeport Harbor General Cargo
(Imports and Exports) and Coastwise



Review of the 2001–2003 fleets showed use of some relatively large carriers for rice exports. The maximum-sized vessels were in the 42,000 to 64,000 DWT range. The design drafts for these vessels are in the 39- to 42-foot range. These larger vessels are used to export rice to Saudi Arabia. In total, rice exports represent an average of 35 percent of total general cargo movements. Annual rice export totals averaged 215,000 short tons for the period 1998–2003.

Over 2001–2003, large bulk carriers were used in the import of limestone and building materials. The vessels used were in the 45,000 to 67,000 DWT range and the design drafts of the vessels in the 40- to 44-foot range. Loaded drafts ranged from 35 to 39 feet. Total limestone imports for 2005 were 433,000 tons. Limestone imports represented 40 percent of 2003–2005 total general cargo tonnage. The majority of imports are from Cozumel, Mexico, and, to a smaller extent, Europe. There is a possibility that some limestone movements may realize deepening benefits.

The remainder of vessels used for general cargo were less than 20,000 DWT and were associated primarily with banana imports. Bananas constitute a significant share of Freeport general cargo; average imports for 1998–2003 were 233,000 short tons. Bananas are transported in refrigerated container vessels, the majority of which are in the 13,000 to 16,000 DWT range.

During initial screening, benefits were not established for these other cargos since petroleum-based cargo was the primary import/export. Also, these cargoes go to the Brazos Harbor Channel docks, which were not being considered for deepening and widening.

6.1.3 Container Cargo/Stauffer Channel Modification

The transportation savings benefits for modification of the Stauffer Channel were investigated, and deepening benefits were calculated. The non-Federal sponsor proposed to extend the existing terminus of the Freeport Harbor Channel to reauthorize and include the Stauffer Channel. The length of the proposed channel would extend approximately 3,400 feet from the 45-foot Upper Turning Basin. The port presently ships and receives general cargo through the Brazos Harbor Turning Basin docks. As part of the feasibility study, optimization of the depth for the channel modification was determined. Depth alternatives of 36, 40, 42, 45, and 50 feet were initially evaluated. The results of the initial screening resulted in a more focused evaluation of a smaller range of depths. Analysis was conducted to determine the competitive advantage that Freeport might potentially have over competing ports. For instance, there is considerable overlap between the Houston and Freeport population centers, and a Freeport container terminal has the potential of capturing associated savings. In addition, Freeport offers an advantage over existing facilities in Houston because terminal capacity in Houston is near capacity.

Analyses then indicated that the most favorable geographic markets for containerized cargo terminal facilities situated in Freeport are some market hinterlands that are presently served regionally by the Port of Houston. The proposed Freeport container facility would be in competition with the Port of Houston facilities, specifically existing Barbours Cut and Bayport, as well as planned phases of facilities at Bayport (Houston) and Shoal Point in Texas City. Presently, Barbours Cut and Bayport are the only facilities in place. Barbours Cut is the Gulf Coast's largest container facility and is the third largest in the Nation and, therefore, the Houston fleet was reviewed as a potential indicator of vessel size expectations.

Table 16 presents the current range of vessel sizes frequenting U.S. Gulf Coast container terminals. In 2003, one of the largest containerships using U.S. Gulf Coast ports included the *MSC Barbara*, an 85,000 DWT vessel operated by the Mediterranean Shipping Company. The *MSC Barbara*, which was constructed in 2002, represented less than 1 percent of container tonnage; however, it was representative of the size of containerships that Freeport wished to attract. For the ERDC ship simulation study, the even larger *Susan Maersk* containership was modeled. The results of the ERDC modeling revealed that none of the pilots controlling the *Susan Maersk* were able to bring the ship safely into the turning basin. In order to safely accommodate this vessel, several other improvements to the channel, including widening, would be necessary. Widening would be needed around the Big Bend area inbound from the Seaway Dock at the lower end of the channel to accommodate the *Susan Maersk*.

Table 16
Representative Gulf Coast Channel Containerships (2003)

DWT Range	TEU Range	% of Tonnage	LOA (feet)	Beam (feet)	Design Draft (feet)	Year Built
<40,000	<3,080	35.6	689	102	38	1996
40,000 to 62,000	3,300 to 4,315	64.0	851	106	42	1988
85,000	6,418	0.4	997	131	48	2002
Design Vessel for Freeport ERDC Ship Modeling: *Susan Maersk*						
104,696	7,226	n/a	1,138	141	48	1997
Additional Container Vessel Under Consideration (*Regina Maersk***, not modeled)**						
85,000	6,418	n/a	1,043	141	46	1996

Based on the results of the ERDC modeling and concerns about project construction cost, smaller container vessels were considered (see Table 16). An additional variable in considering vessel size was the expected frequency of trips associated with S-class containerships. There were several containerships in the 50,000 to 62,000 DWT range calling on the Gulf Coast in 2003, and numerous calls for vessels in the 40,000 to 50,000 DWT range. Review of 2003 vessel transits indicated that vessels over 40,000 DWT transported 64 percent of Gulf Coast container cargo. Most vessels over 40,000 DWT have design drafts of 40 feet. The maximum design draft for vessels in the 40,000 to 50,000 DWT range is generally 42 to 43 feet. In 2003, a significant portion of the 50,000 to 62,000 DWT containerships calling the Gulf were constructed after 1995. Review of the percentage of tonnage by loaded draft showed that 5 percent of vessels were loaded to drafts of 36 feet or more and 3 percent were loaded to drafts of 38 feet or more. Initial analysis examined small container vessels.

6.2 FREEPORT HARBOR CHANNEL INITIAL BENEFIT SUMMARY

Project benefits were initially calculated at FY 05 discount rate of 5.375 percent and for the period 2006–2056. Based on the preliminary economic analysis, the detailed plan formulation would include deepening Freeport Harbor from 45 to 60 feet; widening of the Outer Bar Channel to 600 feet, based on ERDC modeling and pilot input; and deepening and widening the lower 3,700 feet of the Stauffer Channel, based on non-Federal input. The economic summary in Table 14 shows that the net benefits and BCR are maximized at 60 feet deep.

Based on ship simulation testing and cost and benefits analysis, detailed analysis was performed on project channel depths in the range of 55 to 60 feet.

7.0 DETAILED PLAN FORMULATION

7.1 GENERAL

The objective of a feasibility study is to arrive at a recommended plan after a reasonable number of alternatives have been analyzed. This involves a comparison between each alternative and the FWOP conditions and consequences, considering economic, environmental, and social impacts.

As previously noted, subsequent to initial plan formulation, the non-Federal sponsor, Port Freeport, applied to the USACE, Galveston District for a Clean Water Act (CWA) Section 404 permit and an RHA Section 10 permit for dredge and fill activities related to the widening of portions of the Freeport Harbor Channel from 400 feet to 600 feet. Port Freeport proposes to widen, but not deepen, portions of the Jetty Channel and the entire Outer Bar Channel. This decision is an integral part of the current LNG facilities that have been constructed. The proposed permit action, widening only, is within the footprint of this proposed Federal project. The permit project site is located along the northern edge of the Jetty and Outer Bar channels. The permit was granted in March 2009, and construction will begin upon approval by the ASA(CW) for Federal assumption of maintenance. For this feasibility study, the permit construction is assumed to be in place and is considered the future without-project (FWOP-1) condition.

7.2 PROCESS

As detailed plan formulation began, the alternatives were reevaluated. In reevaluation of the Jetty Channel area, it was determined that in order to provide adequate stability of the rock jetties, the bottom width for a 60-foot-deep channel would have to be reduced. It was determined that 540 feet was the maximum bottom width that could be constructed between the jetties and maintain an acceptable factor of safety for jetty stability.

After the conclusion of the preliminary screening, detailed plan formulation focused on the refinement of two Freeport Harbor Channel alternatives determined to be the most feasible: 60-x-540-foot and 55-x-600-foot channel improvements. Detailed plan formulation was also performed for the Stauffer Channel. All nonstructural alternatives had been eliminated. Detailed engineering analysis focused on development of hydrology and hydraulic analysis, channel layout, engineering quantities, geotechnical analysis, operations and maintenance, and cost estimating.

To evaluate the channel alternatives, several studies were conducted by ERDC. The studies included Hydrodynamic/Salinity Modeling, Ship Simulation, Desktop Sediment Analysis, Hurricane Storm Surge, and Shoreline Impacts.

Along with these studies, benefits and cost analyses were conducted for the alternative depth and width alternatives. Since the new project channel in the Gulf of Mexico could extend an additional 2.6 miles, consideration of O&M costs was deemed necessary in conducting the analysis.

Environmental analyses were performed to identify the affected environment and what impacts the project would have on the area. Coordination with the resource agencies was conducted. Cultural studies were conducted for the study area. Mitigation requirements were determined.

The identification of the Recommended Plan was based on economic and environmental factors and local preferences. Costs were estimated for all the alternatives and compared to the benefits. Based on the ship simulation studies, the Brazosport Turning Basin was set at 1,200 feet. No work was proposed for the Brazos Harbor Channel and Turning Basin. Included in the costs are dredging, PA levee construction, and O&M costs for the 50-year period of analysis. Ecosystem mitigation requirements and costs were determined. More-detailed explanation of the analyses is located in the following sections of the report.

During detailed plan formulation, the non-Federal sponsor expressed their preference for a channel deepening and widening project slightly different than the plan resulting from the NED analysis. This plan was designated as the Locally Preferred Plan (LPP). Analysis of the LPP was conducted.

8.0 ENGINEERING STUDIES

8.1 GENERAL

Engineering studies included Ship Simulation, Erosion, and Salinity investigations by ERDC; preliminary geotechnical investigations including sampling/analysis and preparation of a preliminary Dredged Material Management Plan (DMMP); in-house channel surveys; and Architect-Engineer land surveys. Other engineering and design features utilized surveying and mapping, environmental quality/mitigation features, civil design, geotechnical design, structural design, access roads, O&M, cost estimates, data management, and schedules for design and construction. Preliminary alternative designs and screening-level cost estimates were developed in sufficient detail to substantiate the recommended plan and baseline cost estimate.

8.2 DATUM REQUIREMENTS

8.2.1 Datum

All elevations referred to in this report, unless specifically noted otherwise, are based on Galveston District's local MLT datum. This project is a compilation of NGVD 29 and the newer NAVD 88. Existing after-dredged hydro surveys in the local vertical datum of MLT were used in calculating new work volumes. These vertical datum are presented in the studies performed by ERDC and can be referenced for more clarification.

8.2.2 Horizontal

North American Datum (NAD) 27 was used during the initial screening of alternatives. After the Feasibility Scoping Meeting, the study was converted to the newer NAD 83. Final Plates are shown in NAD 83, Texas State Plane Coordinate System, South Central Zone.

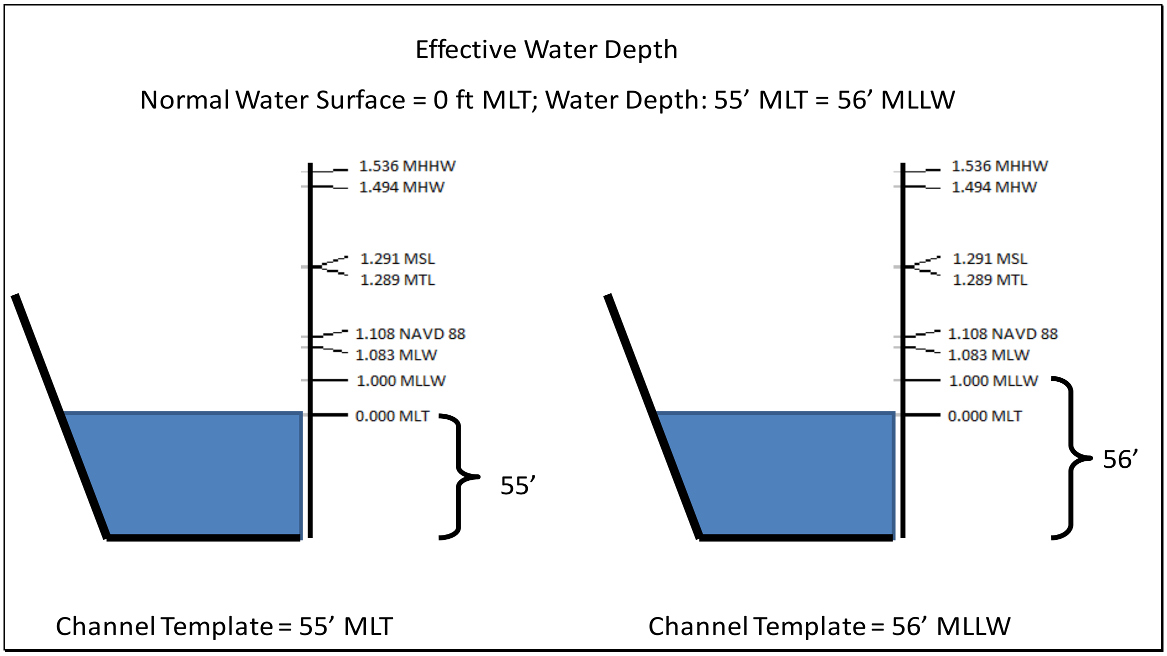
8.2.3 Tidal Datum

Army regulations and HQ guidance on tidal datum, provided in Engineer 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 MLT, to MLLW. EM 1110-2-1003 further states that MLLW should be tied to the NAVD 88. The predominant reasons for conversion to MLLW are the need for consistency throughout the ports of the U.S., to enhance the continuity of National Oceanic and Atmospheric Administration (NOAA) and USCG navigation charts, and to avoid misconceptions within the shipping and dredging industries with regard to channel depths.

8.2.4 Conversion

The Galveston District has an established survey control network along the Freeport Harbor Channel. To comply with the above referenced guidance on referencing tidal datums using MLLW, the Galveston District took vertical survey measurements at tide gages and benchmarks to estimate the relative difference between MLT and MLLW datums along the Freeport Channel. The objective was to maintain an effective water depth of 55 feet while correctly referencing resulting water surface level in MLLW as shown on Figure 9.

Figure 9
Effective Water Depth
Freeport Harbor Channel
Mean Low Tide – Mean Lower Low Water



At Freeport Channel, datum values for MLLW are +1 foot above MLT. However, this does not result in increased water depth, as the additional +1 foot of nominal depth is actually +1 foot above the normal surface water level. Therefore, the actual water depths are equivalent between a 55-foot MLT channel template and a 56-foot MLLW channel template.

As the study and its documentation were completed using MLT, references to MLT have been maintained throughout this document, though numbers are also referenced in MLLW depths at some locations in the report. These references are in parentheses, and the datum is located at each reference point.

8.3 HYDROLOGY AND HYDRAULICS

8.3.1 Modeling Studies

The proposed modification of the navigation channel required several studies, which included field data collection, hydrodynamics, ship simulation, sediment, storm surge, and shoreline impacts. The Coastal Hydraulics Laboratory (CHL) of ERDC conducted all of these studies.

8.3.1.1 Field Data Collection

A field data collection program was conducted during 2003. The primary purpose of the program was to obtain data needed to validate RMA-2 and TABS-MD numerical hydrodynamic models. The secondary objective of the program was to collect data for a desktop study to estimate the shoaling rates in the proposed modified navigation channels.

8.3.1.2 Hydrodynamic Study

The primary objective of the hydrodynamic model study was to provide accurate and representative current velocity fields for use in the ship simulator for the navigation study. The secondary objective was the development of a tool that was used to evaluate the general impacts of the design alternative improvements on circulation in the harbor.

The results showed that the numerical model was reasonably verified against field observations to make it a valuable tool in the evaluation of circulation effects associated with the design alternatives. The effects of the channel deepening were to have the tidal signal arrive about 30 minutes sooner. The tide range was increased only about 0.3 percent. The deepening reduced the currents as much as 0.2 foot per second (ft/sec) in the western side of the channel, with a small localized increase of 0.1 ft/sec on the eastern flank of the channel. There is a greater reduction in ebb current magnitudes than in flood.

8.3.1.3 Ship Simulation

Three initial alternative channel plans developed for Port Freeport for assessment of the new LNG facilities were simulated by ERDC. Simulations were performed on the Entrance and Jetty Channel reach. All three plans assumed construction of the proposed LNG facility. Two of the initial plans were dropped and two additional plans were adapted for simulation. These simulations recommended the 60(MLT)-x-600-foot (61(MLLW)-x-600-foot) channel, the 1,350-foot-diameter turning basin at Brazosport, and some bend widening. The Stauffer Channel improvements were not recommended. Additional simulations were conducted during detailed plan formulation using a smaller containership for the Stauffer Channel and some tapering of the Outer Bar Channel inside the jetty. The two additional plans simulated were 60(MLT)-x-540-foot (61(MLLW)-x-540-foot) and 55(MLT)-x-600-foot (56(MLLW)-x-600-foot) for the Outer Bar Channel.

The additional simulations indicated, based on BRPA comments and test results, no real problems in this area for either the 60(MLT)-x-540-foot (61(MLLW)-x-540-foot)or 55(MLT)-x-600-foot (56(MLLW)-x-600-foot). Navigation issues do not indicate either of these plans in preference to the other. For example, for the 55(MLT)-x-600-foot (56(MLLW)-x-600-foot) channel, the shallower depth may limit the loading of future vessel traffic that can call at the port. For the 60(MLT)-x-540-foot (61(MLLW)-x-540-foot) channel, the narrow width may cause increased tug usage. Given the data collected by the study and the experience of the BRPA, both plans are acceptable alternatives for the Freeport Harbor project.

Later simulations were developed for a 1,200-foot Brazosport Turning Basin, based on a 900- to 990-foot design vessel. Detailed economic analysis determined that this size vessel had the most economic benefits.

8.3.1.4 Sediment Study

The present dredging pattern and quantities would change as a result of the proposed modifications to the Navigation Channel. The objective of this study was to estimate the shoaling rates in the modified Navigation Channel. A desktop study is an alternative method of obtaining preliminary answers without conducting a full-fledged numerical sediment-transport modeling study. Such a desktop approach required field data on sediments, dredging quantities, and velocity results from a hydrodynamic model. In view of variations in salinity and currents in the Freeport system, velocity results from a three-dimensional (3D) hydrodynamic model were necessary.

All data needed for this study were collected in October 2003. Other data needed were obtained from the Galveston District’s Dredging Histories Database, which contains bed sediment data and dredging records.

The 3D model study concluded that there was no significant change or variation between the existing and proposed plan for the tides, currents, salinity, and flow patterns. The quantity of maintenance dredging in the Freeport navigation channel will increase from the present average of 1.6 mcy/yr to 2.92 mcy/yr as a result of deepening and widening the channel to 60 x 600 feet (NED Plan).

Dredging requirements for the LPP/NED Entrance Channel Extensions resulted in one-third of the new dredging volumes for the project. New dredging requirements in the Entrance and Jetty channels are increased by 75 percent due to width and depth changes. Changes in these reaches account for most of the increased dredging requirements for the project. The new dredging requirements in the Freeport Harbor Channel are up 25 percent due to geometry changes. Estimated dredging in the Stauffer Turning Basin is calculated using assumed channel depth at deauthorization (approximately 1950) and at current depth (2009).

8.3.1.5 Hurricane-induced Storm Surge Conditions

A numerical study was conducted to determine whether the planned improvements to the channel would make Freeport Harbor and adjacent low-lying areas more susceptible to inundation due to hurricane-induced storm surge. The improvements modeled were a 60(MLT)-x-540-foot (61(MLLW)-x-540-foot)channel with a 1,350-foot Brazosport Turning Basin, which removed a portion of the southeastern peninsula (North Wave Barrier) that separates the GIWW from the harbor proper, and the proposed LNG improvements. The model found little change in peak water-surface elevations within the harbor resulting from the planned improvements. Estimated increases were about 0.16 foot. Consequently, the planned harbor improvements do not appear to make the harbor and adjacent low-lying areas more susceptible to storm surge from less-intense hurricanes.

8.3.1.6 Shoreline Impact Study

This study assessed the wave-induced impacts of deepening of the Freeport Harbor Channel in the Gulf of Mexico on the open-coastal shorelines adjacent to the project area. Based on coordination with ERDC, the plans proposed for analysis were 50(MLT)-x-600-foot (51(MLLW)-x-600-foot), 55(MLT)-x-600-foot (56(MLLW)-x-600foot), 58(MLT)-x-540-foot (59(MLLW)-x-540-foot), and 60(MLT)-x-540-foot (61(MLLW)-x-540-foot). This study used the numerical model GENESIS to compute sediment transport rates and shoreline change rates for each of the four proposed channels. The conclusion from this analysis is that if any of the proposed deepening alternatives for the Freeport Outer Bar Channel are constructed, the wave-induced sediment transport impacts on the adjacent shorelines will be so slight as to not be noticeable and will be dwarfed by the interannual variability in shoreline position. Within about 0.25 mile of each jetty, the shoreline change rate could increase by up to 1.0 foot per year (ft/year) for the LPP Alternative. However, the background change rates are approximately 10 times greater than the wave-induced impacts attributable to the proposed project, and thus are dramatically higher than the potential change due to the project. In addition, not all of the potential changes would result in an increase in shoreline erosion. A much larger length of shoreline could experience a slight reduction in the erosion rate. In areas from 0.5 to about 3 miles from the jetties, the modeling indicated that the shoreline erosion rate could decrease by up to 0.5 ft/year.

8.4 GENERAL ENGINEERING

During plan formulation, general engineering investigations included such items as turning basins, entrance channel extension, relocation of facilities, berthing/dock areas, bottom widths, channel alignment, bend easing, real estate, placement areas, mitigation and restoration areas, relocations, mitigation relocations, aids to navigation, dredging frequency, predicted shoaling rates, new work dredging, allowable overdepth, nonpay dredging, advance maintenance, and access roads.

8.5 STRUCTURAL

The structural activities conducted were as follows:

- Site visit and obtaining as-built drawings of the shoreline facilities
- Initial evaluation of the shoreline facilities
- Impact evaluation of the shoreline facilities
- Concept design for modifications of each of the impacted shoreline facilities
- Quantity estimate for cost estimating of each of the necessary modifications
- Refine new work PAs for drop-outlet structures
- PA outlet structural design
- Structural engineering appendix report

The structural engineering portion of Appendix B was prepared to provide sufficient information on design input for PA spill boxes for all of the channel alternatives, and impact verification on each bridge, bulkhead, and dock from the proposed dredging. Design of spillbox structures of the new PAs and rehabilitation of existing spillboxes for use of the existing PA were conducted.

Docks and wharves were not analyzed, but several were identified as potentially requiring modifications due to the proposed incremental increases or channel improvement. Dredging volumes were estimated for the dock and berthing areas by taking the area of the berth and multiplying by assumed depth of cut. Associated costs relating to the facility's ability to utilize the new deep draft were identified by others.

8.6 GEOTECHNICAL STUDIES

Geotechnical studies were prepared to provide supporting technical information pertaining to the geotechnical aspects of the Freeport Harbor Project, including the PA site development plan, proposed dredged material distribution to the disposal sites, available project soils information, preliminary design parameters used, and foundation design considerations. Use of available geotechnical investigations information, establishment of suitable design parameters and geotechnical assumptions, and production of quantities for a 50-year DMMP have been performed with the purpose of providing sufficient detail to substantiate the Recommended Plan and the baseline cost estimate.

Borings were obtained from the project area. Soil borings were obtained during the period between November 1962 and September 1978 and generally have been drilled to elevations ranging between 40 to 90 feet below MLT. Additional borings in the vicinity of the channel were obtained by Fugro Consultants, LP, in January and February 2005 under the direction of the Port of Freeport for a separate widening project. Boring logs for PAs 8 and 9 were obtained in

November of 2005, ranging in depth from 30 to 40 feet. Boring logs for existing PA 1 are from boring log data in a report by the Professional Service Industries, Inc., entitled “Subsurface Exploration and Foundation Recommendations for the Proposed Confined Placement Site No. 1 – Port of Freeport – Freeport, TX” that was prepared for and under the direction of the Brazos River Harbor Navigation District in 1996. Borings ranged in depth from about 20 to 60 feet.

Sampling and testing of material was performed. During the drilling of borings referred to in Appendix B, undisturbed sampling of cohesive material was generally achieved by means of using a Shelby or a thin-walled tube with a minimum diameter of 3 inches. Split-spoon sampling was primarily employed on cohesionless to semicohesionless soil layers encountered, whereby disturbed samples were taken concurrent with Standard Penetration Tests (SPT) at various sampling intervals between the different drilling programs employed. Consistencies of cohesive materials were typically determined by means of visual classification, pocket penetrometer tests, and Torvane shear tests. Some basic types of laboratory tests performed on cohesive materials included moisture content, unit dry weight, sieve analyses, liquid limit, and plastic limit. Sieve analyses were also performed on select samples of cohesionless materials. The results of these basic tests along with field boring log data were used to classify various material layers. Through various testing programs associated with borings discussed herein, Unconfined Compression Tests (UC) and Unconsolidated Undrained Triaxial Compression Tests (UU, or Q-tests) on representative samples have been utilized for estimates of undrained shear strengths for “end of construction” or “immediate” foundation loading condition considerations. For undrained shear strength estimates, in some cases the UC and UU laboratory results have been used in conjunction with field testing data and notes on the boring logs, such as pocket penetrometer readings taken, and correlations from SPT testing done on materials encountered during disturbed sampling where some cohesivelike properties were discovered (such as silts, sandy and clayey silts, or clays with various interbedded sand and silt layers).

8.6.1 Dredged Materials and Potential for Beneficial Use

Results from bed sediment studies for data collected between September 1987 and May 2000 indicate the following average percentages of bed sediments have been encountered in the channel:

1. Outer Bar – About 82 percent fine-grained sediments (silts and clays) and 18 percent sands
2. Jetty Channel – About 86 percent fine-grained sediments (silts and clays) and 14 percent sands
3. Main Channel – About 95 percent fine-grained sediments (silts and clays) and 5 percent sands

A review of boring data from the Upper Turning Basin out to the Gulf indicates that new work materials are about 80 to 90 percent clays (of primarily stiff consistency with some traces of silts or clayey silts) and about 10 to 20 percent sands of various densities.

The Federal project considered potential beneficial uses identified by the permit widening action such as beach renourishment and marsh restoration for new work dredged material. While soil borings in the project area indicated some sandy material, no concentrated lenses were identified, and the high percentage of clay material present would not be compatible with existing sandy beach soils in terms of renourishment efforts. The potential for marsh restoration was also precluded because sensitive resources (oysters) and fishing activities exist in some of the proposed restoration areas, and the cost of placing new work dredged material for restoration activities at another site would be prohibitive.

8.6.2 Ocean Dredged Material Disposal Sites

Existing Maintenance and New Work ODMDSs are located within the project area (see Figure 2) at the coordinates below. These are dispersive sites consisting of approximately 1,291 acres and 2,236 acres, respectively, and were originally designated in the EPA FEIS for the Freeport Harbor 45-foot Project in January 1990. In August 2008, USACE gained EPA concurrence for placing maintenance and new work dredged material from the proposed project into these sites.

1) Maintenance ODMDS: The Maintenance ODMDS is located approximately 3 miles offshore and about 1,000 feet southwest of the centerline of the Outer Bar Channel. The site is rectangular in shape with corner coordinates located at:

   28°54′00″N, 95°15′49″W; 28°53′28″N, 95°15′16″W;

   28°52′00″N, 95°16′59″W; 28°52′32″N, 95°17′32″W

2) New Work ODMDS: The New Work ODMDS is located approximately 6 miles offshore. The site is bounded by the following coordinates:

   28°50′51”N, 95°13′54″W; 28°51′44″N, 95°14′49″W;

   28°50′15″N, 95°16′40″W; 28°49′22″N, 95°15′45″W

The offshore placement areas have been modeled. The MDFATE (Multiple Disposal Fate) model was utilized to analyze the effects of offshore placement to ensure conformance with fill height restrictions on the bottom of the seafloor.

8.6.3 Jetty Stability Analysis

Given possible restrictions to channel depth and width due to jetty stability issues, an analysis was performed to determine:

a. the maximum channel width at a project channel depth of 60 feet MLT (61 feet MLLW)

b. the maximum channel depth at a channel width of 600 feet

   (Note: for an authorized depth of 60 feet MLT (61 feet MLLW), it was anticipated that the required depth in the Jetty Channel would be 62 feet MLT (63 feet MLLW) with an allowable overdepth of 2 feet, for the analysis)

Slope stability of the North and South jetties was considered between stations 0+00 to 43+00 (north) and 46+00 (south). Latest available surveys at the time of analysis were reviewed including postdredging channel cross sections dated January 2006 and jetty/channel cross sections dated December 2005. Two project constraints were established regarding the configuration of the jetty slopes:

a. do not undercut the toe of the South Jetty

b. maintain a 50-foot bench at the toe of the North Jetty

8.6.4 Critical Locations and Findings

Slope stability analyses were conducted at Station 10+00 for both the North and South jetties. This cross section was determined the most critical due to a soft clay layer identified in Boring B-6 along the South Jetty. Slope stability analyses were also conducted at Station 20+00 on the North Jetty due to a changed soil profile at this location. Both borings B-5 and 74-23 indicated a loose to medium-dense sand layer at this location. At each cross section, the stability of the existing slope configuration was evaluated. At Station 10+00, the existing slope angle on the South Jetty was projected to a depth of 62 feet MLT (63 feet MLLW), and the maximum channel width was determined that would enable a bench width of at least 50 feet at the toe of the North Jetty. This maximum width was found to be 540 feet. This configuration is labeled 62x540 in Table 17. A second configuration (55x600) was determined by raising the elevation of the channel until a width of 600 feet was achieved. This channel depth was determined to be approximately 55 feet MLT (56 feet MLLW). Both of these configurations hold the slope angle on the South Jetty side resulting in a shift of the existing channel centerline (110 feet to the north for the 62x540 channel and 120 feet to the north for the 55x600 channel). A summary of the calculated minimum factors of safety, resulting from stability analysis for long-term conditions, is provided in Table 17. It was concluded that in order to maintain an adequate factor of safety for jetty stability, the channel alternative would need to be approximately 60 x 540 feet or 55 x 600 feet.

Table 17
Jetty Stability Analysis – Summary of Calculated Minimum Factors of Safety

	Associated Soil Borings	Existing Conditions	62x540 Channel	55x600 Channel
South Jetty (Sta 10+00)	B-6	1.4	1.3	1.3
North Jetty (Sta 10+00)	75-92	1.5	1.5	1.5
North Jetty (Sta 20+00)	B-5, 74-23	1.6	1.5	1.6

Note: Borings B-5 and B-6 taken by Port Freeport contractor, January 2005. Boring 74-23 taken by USACE, August 1974, and Boring 75-92 taken by USACE, October 1976.

8.6.5 Levee and Channel Templates

Slopes of 3 to 1 (horizontal to vertical) were adopted for levee templates and channel cuts, and levee crown widths of 10 feet were used, for generating the feasibility level quantities. Where preliminary stability analyses were pursued, these slope angles were incorporated. Additional and more-detailed stability analyses are anticipated to be done during Preconstruction Engineering and Design (PED). For the channel template, the 3:1 slope is consistent with the original plan presented in General Design Memorandum No. 1 (dated April 1979).

8.6.6 Jetty Sand Retention

The core stone structure in the jetties has been designed to minimize sand transport directly through the structure, and any sand that makes it directly through the actual stone structure is likely very minor. Occasional damage incurred or repair work needed to the existing structure from time to time, to ensure the structure continues to function properly, is typically handled under the existing O&M budget/funding, and thus would not be considered a new cost for the new channel deepening.

8.6.7 Recommended Additional Investigations

8.6.7.1 Freeport Channel

Along Freeport Channel for the new project, during PED, or prior to the final design for the initial construction contract, it is recommended that additional borings be taken at locations that include but are not limited to (1) along the reach above the Upper Turning Basin and along Stauffer Channel at about 1,000-foot intervals to a depth below the depth of new cut, and at other channel locations where gaps or deficiencies are indentified from prior-obtained foundation information; and (2) verification borings or investigations supplemental to prior work done in areas where channel cuts will encroach on critical features or structures such as the jetties.

8.6.7.2 Upland Placement Areas

At existing PA 1, prior to the next O&M construction contract under the new 50-year period of analysis, it is recommended that additional borings be taken at locations that include but are not limited to (1) areas where levee alignment adjustments have taken place since prior drilling work done at the site; (2) locations where results from prior drilling/testing indicate are most critical for additional analyses; (3) locations where gaps or deficiencies in prior foundation information taken are identified; and (4) at select locations within the placement area to assess the latest crust levels from prior dredge fill placement or other soil materials for use as borrow for the initial mechanical levee work.

8.6.7.3 New Placement Areas 8 and 9

At new PAs 8 and 9, prior to the first O&M construction contract, when stockpiled new work material will be shaped to new levee height, it is recommend that additional drilling be performed into levee foundations to verify extent of consolidation and foundation strength gain from surcharge of initial levee and new work stockpiles, and stability checks be performed in critical foundation areas identified.

8.7 COST ESTIMATES

For the Feasibility Study of the deepening and selective widening of the Freeport Channel, two Mii estimates were developed: (1) NED, and (2) LPP. The current existing channel is 45 x 400 feet.

Quantities and design features were developed by the Galveston District Engineering Branch. The estimate was prepared using the latest Unit Price Books and labor rates for FY 2012 (October 2011). The estimate was divided into 8 contracts, with each contract being organized in accordance with the work breakdown structure. The midpoint date of the construction contracts was developed in conjunction with the project manager for developing the fully funded costs. The estimate was prepared in accordance with ER 1110-2-1302, dated September 15, 2008. The costs were escalated in accordance with the above Engineering Regulation and EM 1110-2-1304, dated March 31, 2012. All these data were input into the Total Project Cost Summary (TPCS). The baseline estimate provides for all pertinent elements for a complete project ready for operations.

Since the project is over $40 million, a formal cost risk analysis using Crystal Ball software was done. It was performed with the cooperation of the PDT and Cost Engineering Directory of Expertise (DX) of the Walla Walla District in April 2012. The risks were quantified and a cost risk model developed to determine a contingency at 80 percent confidence level. The new contingencies along with the updated estimates were used to revise the TPCS. The O&M estimate was prepared in April 2012.

The cost estimate has undergone Agency Technical Review and been certified by the DX.

8.8 VALUE ENGINEERING

The Value Engineering (VE) Statement VE for the project was deferred to PED. A study was contracted in plan formulation, but the report was unacceptable (unrealistic conclusions) and never finished.

9.0 DETAILED ECONOMIC ANALYSIS

9.1 GENERAL

This section presents the detailed economic analysis for the Freeport Channel Feasibility Study. The project benefits were calculated based on reductions in transportation costs generated from reductions in vessel delays. The benefits were calculated for a 2017–2067 period of analysis using FY 2012 Federal discount rate of 4.0 percent and the deep-draft vessel operating costs contained in unpublished update to EGM 08-05. The proposed channel improvements are in response to the need for deeper access required by allowing the existing fleet to load more fully, the introduction of larger vessels, and the reauthorization of the upper reaches of the harbor. Additional documentation associated with benefit calculations outlined in this section is contained in Appendix A.

The existing Federal project includes a 47-x-400-foot offshore Outer Bar and Entrance Channel, a 45-x-400-foot Main Channel, and 36-foot depth to its general cargo docks. Figure 10 shows the port facilities and the major terminals. The existing project extends approximately 9.7 miles from its offshore Outer Bar to the base of the Stauffer Channel. A 45-foot project depth extends from the offshore Jetty Channel through the Upper Turning Basin just below the Stauffer Channel. The 36-foot-depth Brazos Harbor Turning Basin, and its associated access channel, intersect the 45-foot channel just below the Stauffer Channel. The Brazos Harbor access channel, harbor, and turning basin contain the majority of existing public facilities, including the multipurpose terminal serving refrigerated and general cargo vessels. Principal commodities include crude petroleum, bulk fuels, chemicals, and general and container cargo. The upper reach of the Main Channel contains the deauthorized Stauffer Channel. Stauffer Channel traffic consists of seismic and crew vessels associated with the offshore oil industry and commercial fishing vessels. Vessel repair and layberth facilities are located on the channel as well. The Stauffer Channel and Turning Basin were deauthorized in 1974 under Section 12, Appendix C, and PL 251. Since deauthorization, the channel depth deteriorated from 25 feet to approximately 18-foot water depth. The depth limitations and impediments associated with silting in the deauthorized channel reach generate safety concerns and contribute to declining utilization patterns. Inclusion of Stauffer as part of the Federal project was evaluated as part of the current study.

9.2 EXISTING CHANNEL USE

Freeport provides access to one of the largest petrochemical complexes in the world. Major petrochemical industries include ConocoPhillips Petroleum, Dow Chemical, and BASF. Located adjacent to the channel is Dow Chemical Company's Texas Division plant. Dow produces large quantities of basic industrial chemicals. Crude petroleum and petrochemical products are distributed from Freeport to the Midwest by pipeline, barge, and rail car. The Seaway/TEPPCO

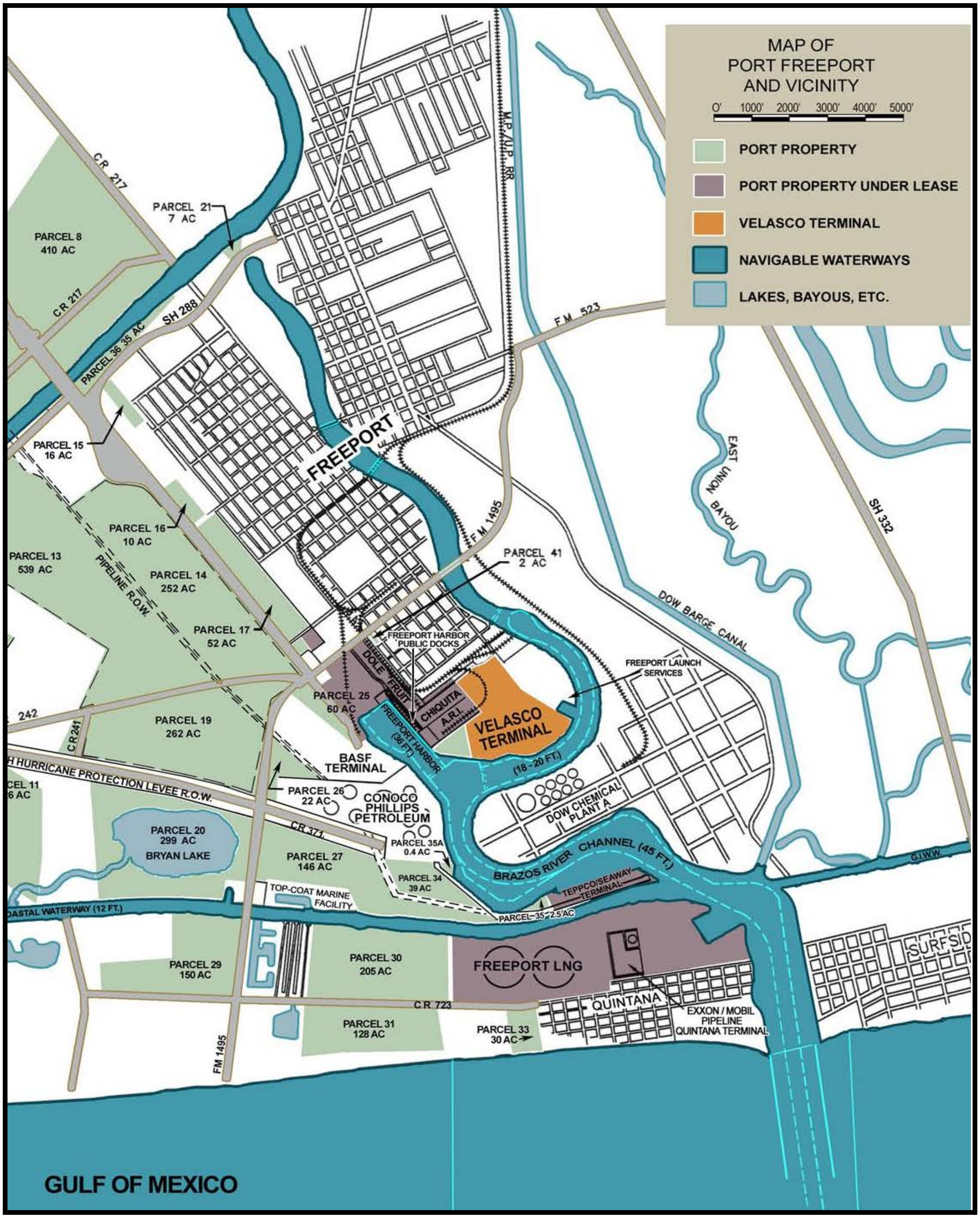


Figure 10
Freeport Harbor Facilities

Terminal receives Suezmax tankers and is located at the lower end of the channel near Station 115+00. Seaway Crude Pipeline Company is a partnership between wholly owned subsidiaries of TEPPCO and ConocoPhillips. The Seaway pipeline extends from the U.S. Gulf Coast to Cushing, Oklahoma. The pipeline also provides regional connections to refineries in Sweeny, Texas City, and Houston. In addition to Seaway, ConocoPhillips has an oil terminal and large tank farm fronting the waterway near the Upper Turning Basin. The crude petroleum tank farm has six storage tanks capable of handling approximately 3.3 million barrels of crude with pipeline connections to their refinery in nearby Sweeny. Sweeny is 28 miles to the northwest of the Freeport Channel. From Sweeny, crude petroleum is transported to Cushing, Oklahoma. Refined products are also distributed by pipelines to western terminals in Colorado and northeast through Kansas, Missouri, and Illinois. A natural gas liquid processing unit and olefins plant, jointly owned and operated by Chevron and ConocoPhillips, is located at the Sweeny complex.

Freeport's crude petroleum terminals also transmit crude oil to the Bryan Mound SPR site. Bryan Mound is 3 miles southwest of Freeport. Two principal crude pipelines extend from Bryan Mound: a 4-mile, 30-inch-diameter line to the ConocoPhillips terminal and docks and a 46-inch line to Sweeny and Texas City, Houston, and the Midwest. The SPR is a U.S. Government complex of four sites with deep underground storage caverns created in salt domes along the Texas and Louisiana Gulf Coast that store emergency supplies of crude oil.

In addition to its existing base and expansion of its new container terminal, the existing condition includes an LNG terminal. The LNG terminal became operational in late 2008 and was constructed by a partnership that includes ConocoPhillips and Dow Chemical. The terminal is located along the southern edge of the Freeport Harbor Jetty Channel near Station 65+00. Its docks were built to accommodate vessels 1,099 feet long by 177 feet wide. This vessel design prompted the non-Federal sponsor to pursue widening of the offshore Outer Bar and Jetty channels from 400 to 600 feet under the Section 204 authority of WRDA 86, as amended in 1990. Phase 1 of the terminal is presently in operation, and vessel traffic commenced in April 2008. Prior to the Section 204 initiative, widening was being evaluated as part of the current Federal feasibility study. While the LNG terminal provided the impetus for the Section 204 analysis, channel widening would also benefit existing and future traffic. Freeport's existing traffic, particularly crude petroleum tankers and product tankers, is subject to vessel size limitations due to the existing 400-foot channel width. The BRPA's current rules stipulate maximum lengths and beams of 820 feet or 145 feet. Daylight-only operation is enforced for vessels greater than 750 feet long or 107 feet wide. Additionally, the beam constraints for existing traffic and introduction of LNG and container vessels are anticipated to exacerbate traffic delays.

While the majority of Freeport's cargo consists of crude oil, bulk fuels, and chemicals, the port's general cargo base also includes a variety of temperature-sensitive cargos such as meat and vegetables. Freeport cargo includes 6 percent of U.S. rice exports and 6 percent of U.S. banana imports. P&O, a multinational container terminal operator and stevedore, currently provides container and terminal operations in Freeport for the special requirements of the Dole, Chiquita, and Turbana fruit distributors. Freeport's refrigerated cargo facility has been in operation since 1984. The fruit distribution facilities were constructed by the port and are leased to the terminal operators. The DWT range for refrigerated cargo vessels is 11,000 to 16,000 DWT. The median beam width of the refrigerated cargo vessels is 79 feet. Analysis of vessel-on-order data from the Lloyd's Register-Fairplay (2007) showed that beam widths of 79 feet represent the maximum for refrigerated cargo vessels. The largest general cargo vessels using the public terminal range from 40,000 to 46,000 DWT. The larger carriers are used for meat, sugar, cereal, and vegetable imports from Brazil and Europe. Freeport's existing temperature-sensitive cargos and rice and other general and containerized base cargo docks are located in the 36-foot-deep Brazos Harbor Turning Basin. Traffic through the general cargo basin also includes wind-energy equipment.

9.3 CHANNEL REACHES

In terms of vessel traffic and facilities, the existing Federal project contains three general operational reaches and one deauthorized reach. The first reach starts offshore at Station –370+00 and goes to Station 132+66, and includes the Lower Turning Basin and the Brazosport Turning Basin. This 45-foot-deep reach provides access to crude petroleum tankers using docks operated by Seaway Crude Pipeline Company. The maximum-sized vessels using the channel are 820-foot-long by 145-foot-wide crude oil tankers unloaded at Seaway. The length and beam of these vessels generally correspond to a 120,000 DWT vessel. Freeport's LNG terminal is also located in this reach. The LNG terminal became operational in 2008 and was constructed by a partnership that includes ConocoPhillips and Dow Chemical. The terminal is near Station 65+00 and adjacent to the intersection of the Freeport Ship Channel and the GIWW. The docks at the LNG terminal were built to accommodate vessels 1,099 feet long by 177 feet wide. This vessel design prompted the non-Federal sponsor to pursue widening of the offshore Outer Bar and Jetty channels from 400 to 600 feet under the Section 204 authority of the WRDA of 1986 as amended in 1990. Larger tankers, in the 135,000 to 175,000 DWT range, are handled on a "per job" basis with a one-time waiver from the BRPA.

The second major reach of the channel extends from the Brazosport Turning Basin to the Upper Turning Basin near Station 184+20. The Upper Turning Basin is 1,200 feet in diameter. Facilities in this reach include Dow Chemical and ConocoPhillips. Vessel traffic consists of product carriers and crude petroleum tankers. The largest vessels using this upper reach are 90,000 to 100,000 DWT crude petroleum tankers. The chemical carriers used in this section generally range in size from 22,000 to 50,000 DWT. The design drafts for chemical carriers at the upper end of this DWT range generally are 42 to 43 feet. Review of the chemical carriers on order as of January 2009 showed that 22 percent have design drafts over 42 feet and 1.6 percent have design drafts over 46 feet, with 48 feet representing the maximum draft.

The next reach is the side channel providing access to the Brazos Harbor Turning Basin and general cargo facilities. The 36-foot-deep channel intersects with the Main Channel at the Upper Turning Basin. Brazos Harbor Turning Basin vessel traffic primarily consists of refrigerated container vessels delivering bananas and general cargo vessels shipping rice. The configuration of the access area and turning basin limits future expansion opportunities due to the high density of docks and landside facilities. The water and landside limitations of the general cargo reaches prompted development of the new adjacent Velasco property for the construction of the new container terminal. The new Velasco Container Terminal is located on property bordering the existing 45-foot Project and the Stauffer Channel and just outside the Upper Turning Basin (see Figure 10). Work is progressing on 800 feet of dock and 35 acres of backland (Phase I), of what eventually will be a 1,200-foot-long dock and a 90-acre terminal (Phase II).

The fourth reach contains the deauthorized Stauffer Channel and turning basin. The Velasco Container Terminal is located in the lower end of the Stauffer Channel between stations 184+20 and 222+00. The upper reach of the Stauffer Channel is from stations 222+00 to 260+00, just below the Freeport Tide Gate. The existing channel depth is 18 feet from stations 174+00 to 260+00.

Until the mid-1950s, the Stauffer Channel had an authorized depth of 30 feet and an operating depth of 25 feet. In 1955, the channel was placed in an inactive status and was deauthorized in 1974 under Section 12, Appendix C, PL 93-251. It has taken over 50 years since being categorized as “inactive” for the channel to shoal from 25 feet down to its current depth of 18 feet from stations 174+00 to 260+00.

The existing project includes four turning basins. The Lower Turning Basin is 750 feet in diameter and located near Station 70+00. Next is the Brazosport Turning Basin, which is 1,000 feet in diameter and is located near Station 110+00. The Brazos Harbor Turning Basin is 750 feet in diameter and is located in the 36-foot channel reach. The Upper Turning Basin is 1,200 feet in diameter and is located at the upper end of the existing 45-foot-deep Federal project and east of the Brazos Harbor Turning Basin access channel.

9.4 EXISTING OPERATING CONSTRAINTS

Freeport’s existing traffic, particularly crude petroleum tankers and product tankers, is subject to vessel size limitations due to the existing 400-foot channel width. The maximum ship dimensions permitted by the BRPA, without waiver, are 820-foot length overall (LOA) and 145-foot maximum beam, as shown in Table 18. Vessel length limitations are enforced because crosswinds and crosscurrents force tankers to “crab” at an angle though the entranced

Table 18
Brazos River Pilots Association Guidelines
Boarding Instructions

Vessel Dimensions:	**feet**	**meters**
Maximum Length	820	249.9
Maximum Beam	145	44.2
Recommended Draft	42	12.8
Draft Restrictions:		
Maximum Draft	45	13.7
Recommended Draft	42	12.8
Brazos Harbor and BASF Channel Maximum Draft	36	10.9
Old River Channel Maximum Draft	15	4.5

Special Cases: Oversized, excessive draft or unusual type vessels will be handled on a "per job" basis with a one-time waiver to the Basic Operating Procedures. These vessels will be billed under "special services" and will be by "specific agreement" prior to the move. Pilots reserve the right to deny movement of any vessel during times of excessive wind, excessive current or on times of low water.

Daylight Restrictions

Inbound Vessels:	
1.	Vessels over 750 feet LOA
2.	Vessels over 107 feet Beam
3.	Vessels with Draft over 36.5 feet and LOA greater than 700 feet
4.	All vessel movements at Dow A-13
5.	All vessel movements at Dow A-14 with LOA greater than 600 feet or with a Beam greater than 100 feet
Outbound Vessels:	
1.	All vessel movements at Dow A-13
2.	All vessel movements at Dow A-14 with LOA greater than 600 feet or with a Beam greater than 100 feet
3.	Vessels sailing from berths above Phillips Bend (Phillips Petroleum Docks, BASF, and Brazos Harbor) with greater than 750 feet. LOA will require two pilots be handled on a per job basis and be billed under the “special services” agreement. One time deviation waiver from standard operating procedures, signed.
	Vessels judged unsafe for handling after dark will be limited to daylight hours. Night operations will be suspended during times when weather conditions do not permit safe navigation.

Source: http://www.brazospilots.com/operatingprocedures.html

Jetty Channel. Ships of greater length than 820 feet are not able to clear the jetties under adverse wind and current conditions. Waivers are only granted provided that winds are less than 20 knots and that there is no more than a 0.5-knot crosscurrent at the mouth of the jetties. Approximately three to four vessels per month are granted waivers. Daylight-only operation is enforced for vessels greater than 750 feet long or 107 feet wide. Additionally, the beam constraints for existing traffic and introduction of LNG and container vessels are anticipated to exasperate traffic delays. Based on pilot input, the effect of channel widening, to be completed under the Section 204 study, will relax these rules.

In the Section 204 study, discussion with the BRPA and ship simulation studies conducted at ERDC found that a channel width of 600 feet would be necessary to accommodate the 264,000 m^3 LNG design vessel. This vessel is 1,131 feet long by 177 feet wide and has a corresponding DWT of 122,000. In general, Freeport presently receives fewer large tankers than other ports with comparable channel depths or even than those with less channel depth due to its existing 400-foot channel width.

With a wider channel, there is reduced potential for delays due to alongshore crosscurrents. Nighttime transits will be possible for vessels larger than 750 feet long and 106 feet wide, and two-way traffic will be possible for a larger range of vessels. Other ports in the region have the capability of handling these larger vessels, so Freeport will not be the only port in the region to accept these vessels.

The ability to deploy larger vessels or load the existing fleet more fully will reduce per ton transportation costs for vessels using Freeport. Larger vessels can carry a greater cargo load than the current restricted size class of vessels, and even with a restricted draft of 42 feet, the greater load should result in a lower cost per ton of transportation, as the percentage increased level of tonnage per ship will be greater than the percentage increase in cost. As a result, cost per ton to move the same level of cargo will decline.

9.5 HISTORICAL TRAFFIC

Freeport experienced strong growth over the past decade. Total tonnage increased from an average of 16.1 million short tons in 1994 to 1995 to an average of 28.5 million for 2004 to 2006. In 2008, Freeport ranked 26th in the Nation in terms of total tonnage, up from 38th in the early 1990s.[2.] In terms of foreign imports and exports, Freeport ranked 12th among U.S. ports in 2007, up from 25th in the early 1990s. Approximately 85 percent of Freeport's current tonnage consists of deep-draft movements. The remaining 15 percent consists of shallow-draft GIWW traffic.

[2] USACE, Waterborne Commerce of the U.S., Part 5, National Summary, Institute of Water Resources (IWR)-Waterborne Commerce Statistical Center (WCSC)-09, 2006–2008 and 1991–1993.

This section provides an overview of recent historical traffic for the existing commodity base. The discussion is limited to crude petroleum, petroleum and chemical products, general and container cargo, and LNG. Inclusion of recent data is based on availability, report preparation time constraints, and relevance to the presentation. Table 19 presents Freeport's 2006 imports and exports by foreign region of origin or destination. Table 20 presents Freeport's tonnage by major commodity groups through 2009.

In addition to the commodity and container traffic, in 2008 Freeport handled 28,000 tons of wind energy equipment, and twenty-one vessels called at the port with wind energy equipment.

9.5.1 Petroleum and Chemical Products

Regional production includes petroleum products such as transportation fuels like gasoline, diesel fuel, and jet fuel, and chemical products such as sodium hydroxide, complex hydrocarbons, and ammonia. For 2004–2006, the petroleum and chemical imports and exports totaled 5.3 million short tons. Freeport's products consist primarily of petroleum product imports and chemical exports. Petroleum products are distributed throughout the Midwest and southeastern United States by pipeline, barge, and railcar. Chemicals are primarily distributed by inland waterway barge.

Table 19
Freeport Harbor
2006 Imports and Exports by Region (all Foreign Imports and Exports)
Estimated Distribution of Imports and Exports by Region of Origin
1,000s of Short Tons

Region	Imports		Exports		Total	
Canada	24.1	0.10%	345.8	11.50%	369.9	1.30%
Mexico	1,133.6	4.70%	42.1	1.40%	1,175.7	4.30%
Central America and Caribbean	1,230.1	5.10%	706.6	23.50%	1,936.7	7.00%
South America	11,118.9	46.10%	739.7	24.60%	11,858.6	43.80%
Western South America	4,10.0	1.70%	12.0	0.40%	422.1	1.60%
Europe and Mediterranean	2,460.1	10.20%	129.3	4.30%	2,589.4	9.60%
Africa	2,894.3	12.00%	177.4	5.90%	3,071.7	11.40%
Middle East	4,843.1	20.08%	141.3	4.70%	4,984.4	18.40%
Far East and Pacific	4.8	0.02%	712.7	23.70%	717.5	2.60%
Total Tonnage	24,119.0	100.0%	3,007.0	100.0%	27,126.0	100.0%

Source: USACE, Navigation Data Center (NDC) detailed unpublished data, 2006.

Table 20
Freeport Harbor Tonnage by Major Commodity Groups (1,000s of short tons) (1970–2009)

	Major Deep-Draft Commodities								
Year	Crude Oil Imports	Petroleum Products Imports	Petroleum Products Exports	Chemical Imports	Chemical Exports	Other	Total Ocean-Going	Inland Waterway Barge Cargo	Total Tonnage
1970	0	0	0	0	1,082	1,209	2,291	2,992	5,283
1980	12,498	221	0	301	1,162	3,117	17,299	2,832	20,131
1990	5,472	17	26	149	1,093	3,407	10,164	4,330	14,494
1991	6,175	38	10	183	967	1,895	9,268	6,398	15,666
1992	5,891	53	14	163	871	2,761	9,753	5,200	14,953
1993	7,025	18	25	176	931	1,564	9,739	4,286	14,025
1994	10,073	259	17	187	1,431	1,483	13,450	4,000	17,450
1995	10,378	1,345	73	344	1,425	1,357	14,922	4,740	19,662
1996	15,074	1,887	27	275	1,418	1,199	19,880	4,691	24,571
1997	16,742	1,863	117	333	1,522	1,272	21,849	4,432	26,281
1998	19,527	1,825	46	255	1,724	1,175	24,552	4,462	29,014
1999	18,321	1,644	39	341	1,633	1,247	23,225	4,851	28,076
2000	19,770	2,054	45	379	2,217	1,685	26,150	4,835	30,985
2001	19,307	2,413	40	583	1,748	1,407	25,498	4,645	30,143
2002	18,019	736	119	663	1,907	1,119	22,563	4,601	27,164
2003	19,672	1,857	87	778	2,104	1,114	25,612	4,925	30,537
2004	20,602	2,873	91	835	2,622	2,093	29,116	4,792	33,908
2005	22,000	1,779	91	691	2,509	1,860	28,930	4,672	33,602
2006	21,706	1,080	109	705	2,551	1,420	27,571	4,576	32,147
2007	18,523	1,046	90	710	2,691	1,005	24,065	5,151	29,598
2008	20,607	955	81	602	2,406	1,347	25,998	3,844	29,842
2009	19,418	220	200	573	1,864	1,063	23,338	4,025	27,363

Source: USACE, Waterborne Commerce of the U.S., Part 2, 1970–2009.

Petroleum product imports experienced high growth after 1994. Imports totaled 259 thousand short tons in 1994 and increased to 1.3 million in 1995, but petroleum product imports are variable. The increases experienced in the mid-1990s were associated with lube oil imports, which represented an average of nearly 70 percent of 1995 to 2000 petroleum product imports. In spite of fluctuating volumes, Freeport's share of U.S. petroleum product imports has remained between 1 and 2 percent since the mid-1990s.

Freeport's petroleum product exports are much lower than imports and are also variable. Freeport's product exports averaged 97 thousand short tons for 2004 to 2006 and represent less than 1 percent of the U.S. total product export. Freeport exports 4.6 percent of U.S. chemicals. Chemical export volumes for 2004 to 2007 averaged 2.6 million short tons and represent record highs.

9.5.2 General and Container Cargo

Container vessels carry any cargo that can be stowed into any of the following container types: general purpose, high cube, hardtop, open top, flat, platform, insulated, ventilated, bulk, refrigerated (reefer), and tank-type containers. Cargo can include merchandise in cartons, bales, drums, cars, furniture, electronics, food, livestock, chemicals, and machinery. Oversized cargo such as heavy machinery, trucks, earth-moving equipment, and pleasure boats can be placed in or on open-top, open-side, or flat rack containers or secured to the tops of several containers in a row.

The range and diversity of container cargo has evolved (Seafarer, 2005). The earliest cargo ships carried a plethora of industrial boxes and packages, but today's container ships have a range of containers to deal with their diverse cargo. There are refrigerated containers that plug into special power sockets; there are containers for grain, liquids, and cars; even containers with clothes hanging inside, ready to go straight on to shop floors. Flat rack containers make a bed for outsized items such as yachts and heavy industrial machinery.

Houston and U.S. imports data show that the region's relative percentage of imports of manufactured goods is twice that for the Nation. Manufactured metal and monumental and building stone compose nearly 20 percent of Houston's manufactured goods total, and represent the single largest subgroups. Other manufactured goods include furniture (6.6 percent); iron and steel products (6.5 percent); baby carriages, toys, games, and sporting goods (5.8 percent); appliances (4 percent); and specialized machinery (3.6 percent). Percentage distributions of U.S. and Houston imports and manufacturing goods are (17 percent); food and farm products (22 percent) and other (5 exports by major group).

9.5.3 Offshore Supply, Offshore Platform Rigs, and Research and Seismic Traffic

Upper Stauffer Channel traffic consists of offshore supply vessels (OSVs), offshore platform rigs, and research/seismic vessels. The majority of traffic falls under the general classification of OSVs. Oilfield shipments consist primarily of fuel, water, supplies, drill pipes, drill mud, and chemicals. In addition to offshore vessels, the channel currently provides cargo vessel repair and layberth service and informally serves as a harbor of refuge.

Under Federal law, vessel-operating companies must report domestic waterborne commercial movements to USACE. The types of vessels include dry cargo ships and tankers, barges (loaded and empty), fishing vessels, towboats (with or without barges in tow), tugboats, crew boats and supply boats to offshore locations, and newly constructed vessels from the shipyards to the point of delivery. Vessels remaining idle during the monthly reporting period are also required to report. Although vessels are required to report, based on 2000 to 2007 dock records available from USACE NDC and subsequent discussion with NDC personnel, the Galveston District concluded that vessel activities not associated with cargo discharge frequently go unreported. The District's search of vessel records associated with Freeport, Galveston, and other Texas ports for the period 2001 to 2007 showed no less than five OSVs. The District received limited lists and picture files of vessels docked on the Stauffer Channel.

Channel users estimated that during the 1970s and 1980s prior to the channel shoaling, a count of 20 to 30 vessels per week used the Upper Stauffer Channel, typically consisting of 6 to 7 crew boats and 18 to 21 supply boats. Industry claims an average of 30 to 40 vessels per month currently use the Upper Stauffer facilities. The 2006 trip statistics obtained from the entrance and clearance records include an annual count of 4 vessels for Freeport. NDC entrance and clearance records showed nearly 100 vessels per month for Galveston and nearly 200 for Bayou Lafourche, indicating that offshore vessels are underreported.

The OSVs using the channel are generally based in Louisiana. The OSV fleet, which includes U.S. and foreign-flagged vessels, comprises crewboats, platform supply vessels, and anchor tugs, which come into Freeport for fuel and general restocking or for waiting 1 to 2 days between jobs or due to inclement weather. For longer stays, Louisiana-based vessels would likely go to their homeport in order to avoid port charges.

According to industry literature, the OSV fleet primarily serves exploratory and developmental drilling rigs and production facilities, and supports offshore construction and subsea maintenance activities.[3] OSVs differ from other types of marine vessels in their cargo-carrying flexibility and capacity to transport deck cargo. OSVs carry pipe or drummed material and equipment, liquid mud, potable and drilling water, diesel fuel, dry bulk cement, and personnel between shore bases and offshore rigs and facilities.

The OSV fleet working in the Gulf of Mexico consists of U.S. and foreign flag vessels. The classification of foreign flag OSVs is addressed under 46 CFR Subchapter L as published in the *Federal Register* of 19 September 1997. OSVs of 500 gross tons (U.S. Regulatory Tonnage) but less than 6,000 gross tons meet the requirement of 46 CFR Subchapter L and additional requirements from Subchapter I (Industrial Vessels) that are applicable to OSVs carrying less than 36 offshore workers. Current legislation allows foreign flag vessels to operate within the U.S. boundaries of the outer continental shelf.

Foreign flag OSVs are generally exempt from Section 27 of the 1920 Merchant Marine Act, commonly referred to as the Jones Act. The Jones Act restricts U.S. coastwise trade to U.S.-built, U.S. coastwise citizen-owned, and U.S. flagged vessels. The Jones Act was extended to the U.S. outer continental shelf by the Outer Continental Shelf Lands Act of 1953, as amended in 1978.

[3] Hornbeck Oil Services, webpage information

The U.S. Gulf Coast OSV fleet includes five subtypes. The subtypes are anchor-handling tug supply vessels, crew supply vessels, offshore tug supply vessels, pipe carriers, and platform supply vessels.

Platform Supply Vessels (PSVs) are specially designed for transport of supplies to/from offshore installations, mainly to supply fields in production. This involves the transport of individual items, mainly in containers on deck. In addition, a PSV transports in segregated systems a variety of different products such as methanol, preblended drill fluids, brine, water, and oil. The various fluids are contained in epoxy-painted tanks, with individual pumps and hoses. Dry bulk cargo such as cement, barite, and bentonite are also transported. At the installations, this cargo is discharged by using compressed air. PSVs and anchor-handling and supply tugs are characteristically the largest vessels in the OSV general grouping.

Seismic vessels are used by the oil and gas industry for acquiring drilling data. The boom in offshore exploration and surveying has made seismic vessels key to the industry. Over the past 10 years, many foreign seismic vessels have utilized Freeport for a base of operations and conducted refitting projects. Activities include vessel refitting for mobilization at Gulf of Mexico and in foreign exploration sites. Seismic vessels are normally out to sea no more than 50 to 55 days, then they return to dock for a week and go back out to sea for another 50 to 55 days.

In addition to oilfield-related vessels, the Stauffer Channel provides layberth and associated repair services for small cargo vessels, fishing vessels, and other miscellaneous craft. Research vessels are characteristically layberth customers. Dwell time for layberthing generally ranges from 4 to 6 months.

Vessels have been turned away due to the lack of sufficient water depth.

9.5.4 Liquefied Natural Gas

The Freeport Section 204 widening analysis includes detailed analysis of Freeport's LNG market. The Section 204 report shows that import volume of 84.2 billion cubic feet per day was forecasted for 2010, with volumes increasing to 712 billion cubic feet by 2018. The vessel sizes and expected throughput prompted the non-Federal sponsor to pursue widening of the offshore Outer Bar and Jetty channels from 400 to 600 feet under the Section 204 authority of the WRDA as amended in 1990. While LNG provided the impetus for the 204 study, channel widening would also benefit existing and future traffic. The base analysis used for this feasibility study assumes that the channel is widened.

9.6 HISTORIC VESSEL UTILIZATION PATTERNS

This section discusses vessel utilization patterns before and after the 45-foot Project depth became available in the mid-1980s. Freeport experienced an overall increase in the number of vessels associated with loaded drafts over 38 feet from the years 1992 to 2006. In 2006, 265 vessels had loaded drafts over 38 feet. Current volumes associated with loaded drafts of 38 feet or more are over 150 percent higher than when the 45-foot depth first became available. Comparison of the data from the early 1990s shows small variation in the total number of ocean-going vessels used for cargo transport but significant increases in ocean-going tonnage, with total ocean-going tonnage nearly three times greater than in the early 1990s.

While total trips declined from 2,460 in 1992 to 1,690 in 2006, trip counts for some groups grew. Along with increases in trips for vessels with loaded drafts over 38 feet, there were significant increases in the number of movements associated with loaded drafts of 25 feet or more.

General cargo vessels also increased in loaded drafts. In 1993 and 2006, loaded drafts for vessels used to import bananas and export food showed a change from average loaded drafts of 25 feet or less in the early 1990s to 25 feet or more for recent years. While the largest concentration of banana and food product movements are associated with loaded drafts between 25 and 29 feet, some loaded drafts between 36 and 39 feet are used for food products, specifically meat and rice.

9.6.1 Underkeel Clearance

Underkeel clearance is defined as the minimum clearance available between the deepest point on the vessel and the channel bottom, in still water. The general rule of the BRPA indicates the underkeel clearance be at least 10 percent of the design draft minus 1 foot, but BRPA said it is their understanding that since the grounding of the Exxon *Valdez* and OPRA 90, the USCG has required a minimum of 3-foot underkeel clearance for all tank vessels. Interpretation of the BRPA rule suggests that loaded drafts in excess of 42 feet should be very rare for the current 45-foot channel.

Freeport's tanker fleet was examined in order to identify the vessel loading patterns. The effect of underkeel clearance policy on existing and future traffic results in greater underkeel clearance for larger vessel sizes. The 2005 and 2006 records show some vessels less than 100,000 DWT being loaded up to 42 feet and vessels over 115,000 DWT not being loaded greater than 40 feet and ranging from 34 to 40 feet.

9.6.2 Commodity-Specific Vessel Utilization

This section presents analyses of vessel fleet data, utilization of the existing fleet, and anticipated future constraints associated with draft-constrained vessels. These analyses provide the basis for identifying the commodities expected to utilize vessels loaded to channel depths over 45 feet and for forecasting percentage utilization of larger and/or more fully loaded vessels. The discussions include vessel fleets for petroleum, petroleum products, chemicals, breakbulk, container cargo, OSVs, Seismic, Research, and LNG vessels.

9.6.2.1 Crude Petroleum Tanker Fleet

The largest vessels presently using Freeport are crude petroleum tankers. The most common sizes presently using Freeport are between 90,000 and 110,000 DWT, and the largest vessels presently used are in the 145,000 to 159,500 DWT range. Table 21 presents distributions of crude petroleum imports by vessel size for 1990, 1993, and 2003 to 2007. Table 22 displays representative vessel characteristics corresponding to Freeport's current crude petroleum fleet.

Table 21
Freeport Harbor Crude Petroleum Imports by Vessel DWT, 1990–2007 (Percent)

DWT Range	1990	1993	2003	2004	2005	2006	2007
<50,000	1.1	–	–	–	1.1	0.7	1.3
50,000 to 69,000	98.9	11.8	3.1	0.9	3.3	1.8	2.2
70,000 to 79,999	–	–	0.3	4.2	3.4	6.6	5.0
80,000 to 84,999	–	24.9	5.3	4.1	1.5	–	–
85,000 to 89,999	–	35.6	5.7	1.2	1.0	–	–
90,000 to 94,999	–	–	5.5	6.2	5.7	9.5	7.2
95,000 to 99,999	–	16.9	36.3	35.8	34.5	24.3	23.4
100,000 to 104,999	–	10.8	10.9	13.7	12.6	13.6	22.5
105,000 to 109,999	–	–	26.7	22.2	27.3	31.5	25.6
110,000 to 114,999	–	–	3.3	7.6	5.2	5.6	6.6
115,000 to 119,999	–	–	–	–	–	1.0	2.2
120,000 to 139,999							–
140,000 to 159,000	–	–	2.9	4.1	4.4	5.3	4.2
Total	100	100	100	100	100	100	100

Source: USACE, NDC, unpublished data.

Table 22
Freeport Harbor
Crude Petroleum Representative Tanker Sizes

DWT Range	Vessel Characteristics (feet)		
	LOA	Beam	Design Draft
<80,000	748	106	41
80,000 to 84,999	800	131	43
85,000 to 89,999	800	138	46
90,000 to 94,999	810	136	46
95,000 to 99,999	798	137	47
100,000 to 104,999	792	138	48
105,000 to 109,999	797	138	50
110,000 to 114,999	817	144	49
115,000 to 139,999	820	144	53
140,000 to 155,000	899	154	56

Source: USACE, NDC unpublished data were used to compile the percentage distribution of tonnage by vessel size. The Fairplay/Lloyd's Register of Ships was used to obtain the vessel DWT and associated characteristics.

9.6.2.1.1 Crude Petroleum Modes of Shipment

The modes of shipping crude include direct, lightered, lightened, and transshipped. Direct shipment is the transfer of tonnage by vessel between two coastal ports. Lightering is defined as the process involving ship-to-ship transfer of oil cargo. Lightening describes the process where enough cargo is offloaded from a tanker to permit the light-loaded vessel to enter a confined channel system. Transshipments store crude at a terminal and then ship direct from there to ports such as Freeport.

U.S. Gulf Coast lightering occurs in the international waters of the Gulf of Mexico and involves the transfer of tonnage from a larger vessel, called a VLCC (Very Large Crude Carrier), onto one or more shuttle vessels. With lightering, the VLCC does not enter the coastal receiving port.

Lightering is extremely cost effective for long-haul freight. Tankers larger than 175,000 DWT are normally totally lightered offshore onto shuttles. For Freeport's existing project depth of 45 feet, four shuttles are needed to completely offload a 325,000 DWT VLCC, with 325,000 DWT being a representative VLCC size. The use of four shuttles is routine and optimal as it allows for the least number of shuttles based on a 45-foot channel depth.

A frequent alternative to either direct shipment or lightering is lightening. The tanker sizes associated with lightening on the Texas Coast generally range from 120,000 to 175,000 DWT. Tankers larger than 175,000 DWT are normally lightered. There is a gap in the world tanker fleet between 175,000 and 250,000 DWT. The reason for the gap is that it is not cost effective to use tankers significantly larger than 175,000 DWT for direct shipment even for channel depths of 55 to 60 feet, and it is not cost effective to use vessels smaller than 250,000 DWT for lightering.

The transportation costs prepared for this report are based on optimal shuttle sizes and turnaround times. It was found that the efficiencies of offshore transfers are great and have increased in the last 10 to 15 years, and therefore the assumption of optimal efficiencies is reasonable. Offshore off-loading rates are less than dockside rates. The maximum cargo capacity for a 325,000 DWT vessel is approximately 347,400 short tons. Information obtained from industry discussion indicates that the set-up time and finishing time would add a few hours. Shuttle vessels are loaded one at a time and sequencing of shuttle vessel arrivals and departures is subject to variances.

Transshipping is the fourth mode of shipment. Crude oil is also transshipped through deepwater ports in the Caribbean. Crude is transported on VLCCs to the transshipped sites and later transferred to 90,000 to 114,000 DWT range shuttle tankers for shipment to Freeport. Some of the tonnage included in the Central and South America routing is transshipped through the Bahamas. Based on similar mileage and vessel sizes, the cost analysis for tonnage transshipped through the Bahamas was evaluated similarly to direct shipments from ports in Venezuela and Colombia.

The primary sized vessel used on the Mexico/Eastern South America route for direct shipments into Freeport is 90,000 to 114,000 DWT. Western South American shipments are either transported through the Panama Canal or the Trans-Panama Pipeline. The 81-mile pipeline runs from Panama near the Costa Rican border and the port of Charco Azul on the Pacific Coast to the port of Chiriquí Grande, Panama, on the Caribbean Sea. The pipeline opened in 1982 as an alternative to carry crude oil from the Pacific to the Atlantic. Between 1982 and 1996, it transported approximately 2.7 billion barrels of Alaskan oil to the U.S. Gulf Coast ports. After declining Alaskan oil shipments, the pipeline was closed in 1996. In November 2003, it was reopened for transportation of Ecuadorian crude oil to U.S. Gulf ports. Less than 1 percent of Freeport's 2004 to 2006 crude oil imports originated in Ecuador and was transported in relatively small tankers. Nearly 50 percent of crude oil imports originated in Venezuela and approximately 30 percent was from West and North Africa and the Middle East. Table 23 presents Freeport's 2000 to 2009 crude petroleum imports by major trade route. The USACE NDC records only include vessels that come into U.S. ports, such as Freeport, and do not include records of vessels that offload at the lightering zone. Table 23 displays Freeport's 2000-2009 crude petroleum imports by region or country of origin.

Africa, Mediterranean, and Europe movements are lightened, lightered, or shipped direct. Shipments from Africa, the Mediterranean, and Europe are usually transported in tankers between 90,000 and 175,000 DWT, with direct shipments generally using tankers between 90,000 and 120,000 DWT. Facilities to accommodate VLCCs recently became available at Africa ports.

In addition to transportation cost incentives, vessel selection is also related to the way crude petroleum is currently sold and how crude oil is shipped. Parcels are generally sold in 500,000 to 650,000 barrels. A 500,000 to 650,000 barrel parcel converts to approximately 75,000 to 95,000 short tons. Many vessels arrive in the international waters of the Gulf of Mexico with double parcels. Cost analyses show that the most economical sized vessel for single parcels is between 75,000 and 100,000 DWT given the existing channel depth of 45 feet. For double parcels, the most efficient size is between 150,000 and 175,000 DWT.

Gulf Coast industry personnel indicated that parcel size and associated ship size are primarily a function of the existing channel dimensions. The indication suggests that an increase in channel dimensions would likely result in a shift to larger parcel sizes and larger vessels. Comparison of the parcel sizes associated with Freeport's 1993 and 2007 crude oil imports revealed that the distribution of tonnage by parcel size increased. Data for 1993 were chosen to represent conditions when the 45-foot channel was dredged. Transition to more fully loaded, or larger, vessels is generally expected to have some lag time. Comparison of Freeport's current crude oil import parcel sizes for 1993 and 2007 indicate reductions in the volumes discharged offshore. The data comparison also serves to illustrate that larger parcels are being shipped today and suggests that the channel deepening from 40 to 45 feet facilitated this transition. Table 24 displays percentage distributions of Freeport's 1993 and 2007 imports by parcel size.

Table 23
Freeport Crude Petroleum Imports by Region or Country of Origin
2000–2009

Region of Origin	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1,000s of short tons										
Canada	-	-	-	-	-	-	-	-	270	56
Mexico and Guatemala	1,068	328	324	1,829	288	800	428	748	1,071	1,368
Venezuela and Colombia	5,120	11,932	10,938	6,197	8,776	12,676	11,390	9,143	9,096	6,177
Brazil and Argentina	-	-	-	-	-	823	834	713	514	2,116
W. South America	-	-	-	-	-	204	115	92	-	754
Europe, N. Africa, and Mediterranean[a]	4,642	2,085	2,540	3,380	3,241	1,916	2,990	1,682	3,357	3,887
West Africa	4,760	2,606	2,342	3,400	3,158	4,625	2,756	3,190	3,430	3,674
Mideast	4,180	2,356	1,875	4,865	5,138	957	3,193	2,956	2,869	1,089
Pacific/Far East	-	-	-	-	-	-	-	-	-	296
Total	19,770	19,307	18,019	19,672	20,602	22,000	21,706	18,523	20,337	19,362
Percentages										
Canada	-	-	-	-	-	-	-	-	1.3	0.3
Mexico and Guatemala	5	2	2	9	1	3.6	2.0	4.0	5.2	7.0
Venezuela and Colombia	26	62	61	32	43	57.6	52.5	49.4	44.1	31.8
Brazil and Argentina	-	-	-	-	-	3.7	3.8	3.8	2.5	10.9
W. South America	–	–	–	–	–	0.9	0.5	0.5	0.0	3.9
Europe, N. Africa, and Mediterranean[a]	23	11	14	17	16	8.7	13.8	9.1	16.3	20.0
West Africa	24	13	13	17	15	21.0	12.7	17.2	16.6	18.9
Mideast	21	12	10	25	25	4.4	14.7	16.0	13.9	5.6
Pacific/Far East	0	0	0	0	0	0.0	0.0	0.0	0.0	1.5
Total	100	100	100	100	100	100.0	100.0	100.0	100.0	100.0

Source: USACE, NDC detailed files and U.S. Department of Energy

[a] The majority of this tonnage is lightered or lightened. The tonnage total shown includes shuttle vessels and lightened mother vessels.

Table 24
Freeport Percentage of Crude Oil Imports by Vessel Parcel Size
1993 and 2007

Vessel Parcel (short tons)	% of Imports by Parcel Size	
	1993	2007
≤60,000	32	11
60,000–70,000	13	6
70,000–80,000	44	18
80,000–85,000	5	11
85,000–95,000	7	54
Grand Total	100	100

Source: USACE, NDC compiled from detailed records.

Data show that the larger parcels are being carried by the larger DWT classes. This transition suggests more cost effective use of vessels. In addition, recent data show the use of some smaller shuttles to accommodate smaller volumes discharged during lightening operations.

9.6.2.2 Petroleum Product Vessels

Since the 45-foot depth became available in the mid-1990s, there has been a transition to larger and more fully loaded vessels for some petroleum product tonnage, including partially refined oils. Partially refined oils are transported in crude petroleum tankers. The geographic origins generally include Algeria (47 percent) and Saudi Arabia (27 percent). Other origins include Southern Europe, the Mediterranean, and Ecuador. Vessel sizes and trade route data indicate potential opportunities to load to increased drafts based on trend data through 2005. Data for 2006 to 2009 show a drop in partially refined products imports and the associated use of relatively larger vessels.

9.6.2.3 Chemical Product Carriers

Larger chemical carriers are using Freeport more than in the 1990s. Detailed examination of data for 1990, 1993, and 2002 to 2005 revealed that beginning in 2002 some chemical exports were transported in vessels loaded to 40 feet or more[4]. The destination ports for these shipments include Brazil, Eastern Canada, and the Far East.

Data show an average of 7 percent of 2003 to 2009 tonnage was transported in vessels with loaded drafts of 40 feet or more. The 2003 shipments were divided among Brazil, Eastern Canada, and the Far East. The 2004 shipments were exported to China. In 2005, the larger shipments were exported to Brazil. Approximately 22 percent of exports were shipped to locations for which the Panama Canal provides the shortest travel distance. Nearly 95 percent of

[4] Continuous detailed data for years prior to 2001 are not readily available.

this tonnage consisted of chemicals. The destinations of shipments through the Panama Canal included South Korea (36 percent), Japan (19 percent), China (16 percent), Australia and New Zealand (15 percent), Singapore (11 percent), Indonesia (2 percent), and Western South America (1 percent). For the period 2007 to 2009, 41 percent of vessels with loaded drafts of 40 feet or more exported chemicals to Brazil, 32 percent to Asia, 18 percent to Northern Europe, and 9 percent to Eastern Canada.

Freeport's largest shipments and more deeply loaded vessels carried sodium hydroxide (commonly referred to as caustic soda). Caustic soda is used in the manufacture of pulp and paper, alumina, soap and detergents, petroleum products, and chemical production. The production of alumina from bauxite is a major end-use application for caustic soda. Caustic soda composes 30 percent of Freeport's 2003 to 2005 chemical exports and approximately 50 percent of 2006 to 2007 exports.

9.6.2.4 Bulk Carriers

Large bulk carriers are used in the import of Freeport's limestone and building materials. The specific type of bulk carriers used for limestone and building materials are "load-on/load-off," or "LoLo," vessels. The present fleet generally consists of 45,000 to 67,000 DWT vessels with design drafts between 40 feet and 44 feet and loaded drafts ranging from 35 feet to 39 feet. The median year of construction for the range of vessels used for this trade is 1985 and is older than the median of 1998 associated with the world fleet. Review of the distribution of vessels on order and channel depths at receiving ports indicates that some transition in the average DWT range from the existing 60,000 to 70,000 DWT into the 80,000 to 94,000 DWT range is reasonable to expect. A portion of future bulk traffic is anticipated to move to the Velasco Terminal dock. This move will allow for the use of larger and more fully loaded bulk carriers.

Rice is transported in general cargo vessels, and the size of these vessels has increased over the last decade. The largest general cargo vessels using the public terminal range from 40,000 to 46,000 DWT. The larger carriers are used for meat, sugar, cereal, and vegetable imports from Brazil and Europe. Also transported in general cargo vessels is wind-energy equipment. While more deeply loaded vessels are not anticipated for the turning basin reach, the port is expanding general and container cargo facilities just outside the turning basin reach due to capacity constraints within the basin and to accommodate larger container vessels for a wider range of commodities.

9.6.2.5 Container Vessels

Bananas and rice are transported through docks located within the Brazos Turning Basin. Bananas constitute a significant share of Freeport general cargo. Freeport imports 6 percent of U.S. banana imports. Average imports for 2003 to 2005 were 257,000 short tons and remained relatively constant over the most recent 10-year period.

Bananas are transported in refrigerated container vessels, the majority of which are in the 13,000 to 16,000 DWT range. The median beam width of the refrigerated cargo vessels is 79 feet. Distribution of vessels on order shows no indication of a transition to larger refrigerated cargo vessels and shows the median beam width of the future is not expected to increase.

An annual volume of approximately 200,000 TEUs is expected during the first full year of operation with one to two vessels per day. A base of 200,000 TEUs represents 0.3 percent of the U.S. container throughput. A full build-out of 800,000 to 1,200,000 TEUs is planned with three construction phases.

Data display changes in the general cargo and container vessels using U.S. ports between 1999 and 2006 and indicate moderate rates of growth. The pace of transitions that occurred between 1999 and 2006 is expected to increase with the Panama Canal expansion. Larger Panamax and post-Panamax container vessels are presently using U.S. Gulf Coast ports. In 2006, 40 of Houston's container vessels were post-Panamax. These vessels, which have design drafts of 48 feet, transported approximately 8 percent of Houston's 2006 containerized imports and 10 percent of exports. Overall, foreign ports represented the first port of call for 45 percent of outbound containerships.[5]

Houston's first domestic port-of-call shipments were from nearby locations such as Mexico (129 vessels), Guatemala (54 vessels), Colombia (43 vessels), Jamaica (15 vessels), Dominican Republic (7 vessels), the Bahamas (5 vessels), and Western Europe. Houston was the first port of call for shipments from Spain (35 vessels), France (25 vessels), and Italy (20 vessels). Houston's container terminals presently have depth constraints of 40 feet, and the maximum loaded draft is 39 feet. The channel depth at the container terminals at many of these ports exceeds 40 feet. Specifically, a channel depth increase from 41.9 to 49 feet is planned for the container terminal in Cartagena, Colombia, and an increase from 42 to 51 feet is planned in Kingston, Jamaica. Container terminal improvements in Santos, Brazil, from 42.3 feet to 52 feet are planned.[6] The container terminal in Algeciras, Spain presently has a channel depth of 54 feet, and the Italian terminal of Galliari has a channel depth of 49 feet.

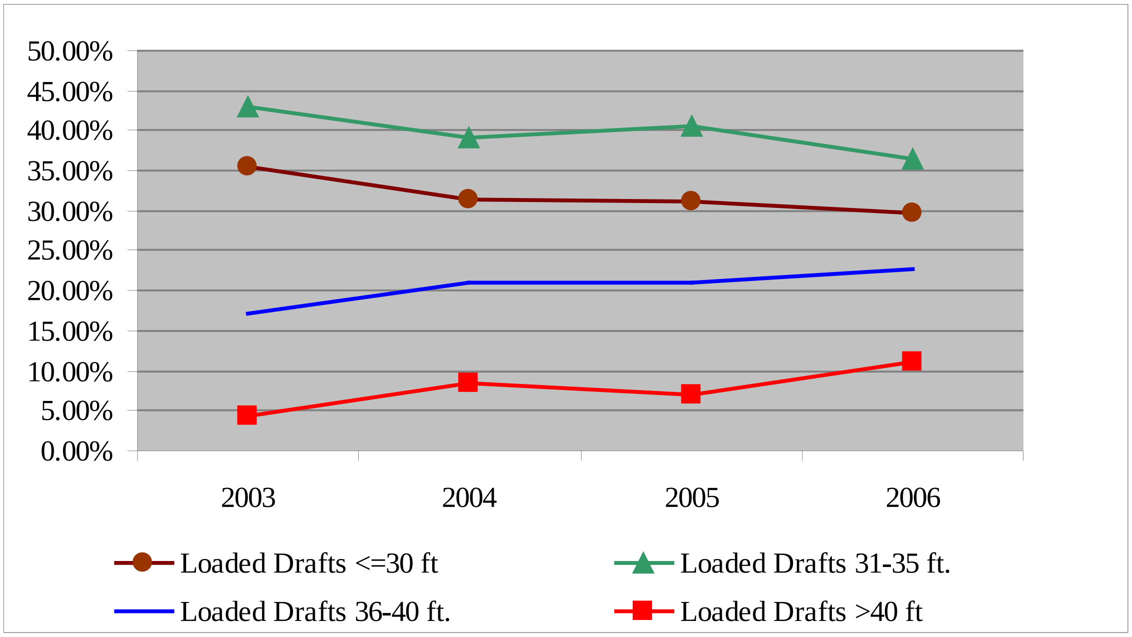
Containerships from 60,000 to 68,000 DWT are representative of mid-sized container vessels and use Houston on a regular basis. These vessels, which have design drafts up to 45 feet, are also representative of the upper end of Panamax containerships.

Figure 11 provides a general illustration of regional changes in loaded draft patterns for 2003 to 2006.

[5] The itineraries for inbound vessels were not available.

[6] Channel-depth information was obtained from Inter-American Committee on Ports, Organization of American States, presentation prepared by Carlos M. Gallegos, http://aapa.files.cms-plus.com

Figure 11
U.S. Total Containership Trips
Percentage of Trips by Loaded Draft (2003–2006)



9.6.2.6 Offshore Supply, Seismic, and Research Vessels

Navigation constraints arose after the channel was deauthorized in 1974. A channel that is non-federally maintained presents a navigational hazard in the form of higher accident probabilities. Nonmaintained water depth also presents a financial hazard to the businesses located at the end of the channel. Maintaining alignment is difficult in the silted channel. Sufficient underkeel clearance is extremely important to vessels carrying expensive and highly technical equipment. The channel depth limitations can cause hull and propulsion damage.

In spite of limitations, the channel is still used as a Harbor of Refuge. However, the range of vessels that can be safely served is limited. For example, in 2008 during Hurricane Gustav evacuation, an offshore anchor tug attempted to enter the channel and struck a submerged object and grounded. Damages sustained to one of the vessel's cyclonical thrusters required the vessel to be towed back to its home base in Louisiana after the storm. Offshore anchor vessels typically have cyclonical thrusters that are not removable. The damaged vessel had a design draft of 24.6 feet and was in ballast when it grounded.

A result of reduced depth is a reduction in vessel activity. Vessels are routinely turned away. An inquiry made to BRPA revealed that the pilots do not keep lists of vessels that are turned away. Based on the lack of records of vessels turned away, a detailed investigation of anecodotal information and vessel types similar to those presently using the Stauffer Channel was performed. For example, on 9 March 2009, a 24.6-foot draft vessel requesting to come in for layberth was turned away due to insufficient channel depth. It was also found that the seismic vessel, *Osprey* was turned away because of insufficient channel depth. *Osprey Explorer* has a design draft of 19 feet. It was a challenge docking the *GSI Admiral*. Frequently, captains cannot agree to bring vessels in due to written rules.

Draft restrictions of just a few feet may result in unplanned delays necessitating reductions in ballast and/or in fuel. Vessels affected by draft restriction will unload fuel or ballast at docks at the lower end of the Freeport Channel before getting to the Upper Stauffer. Ballast and fuel adjustments are later made upon leaving. The time taken for ballast and fuel adjustments results in added operating time and docking charges. For instance in March 2011, the seismic vessel *Discoverer,* which has a design draft of 15.4 feet, was able to take on ballast water necessary for offshore hull balance, it was not able to fully load fuel. The inability to fully load fuel meant the vessel had to make an additional stop down-channel for fuel.

All 2006 records for Freeport, Galveston, and Bayou Lafourche (Louisiana) were obtained from Lloyd’s Vessel Register records. The USCG and the USACE’s Transportation Lines of the U.S. vessel databases were used to obtain vessel characteristics for some of the vessels not found in Lloyd’s/Fairplay. The loaded drafts and general vessel size data, as indicated by net registered tons and gross tons, included in the USACE’s Entrance and Clearance file were initially used to help isolate OSVs.

The largest vessels using the channel are approximately 400 feet long. Longer vessels cannot be turned and have to be backed into the channel. Crew and supply vessels have a draft range of 15 to 18 feet. Supply vessels, which made six to seven trips per week, have a draft range of 20 to 30 feet. These vessels fall under the general classification of OSVs.

Associated vessel characteristics were extracted from the Lloyd’s vessel databases and matched to the NDC records in determining vessel type. The vessel databases were particularly important in identifying vessel types such as OSV, research vessel, seismic vessel, and crew boat.

A BRPA pilot is required for all foreign flag vessels regardless of size. A pilot is also required for any U.S. flag vessel coming from a foreign port. U.S. vessels coming from the international waters of the Gulf of Mexico do not require pilotage.

In addition to the OSV statistics in the Fairplay/Lloyd’s Register of Ships, statistics associated with OSVs registered with the USCG in 2006 and operating in U.S. offshore, and vessel design draft and other characteristics for the 551 USCG vessel records available from the USACE’s web page were compiled. The percentage of OSVs built after 1974 and the percentage built after 2000 were determined. The largest increases are primarily associated with design drafts over 20 feet. The data were used to identify the range of vessel drafts associated with the fleet that includes vessels using Freeport.

Seismic vessels are usually similar in size to oilfield supply vessels. They can range from 100 to over 350 feet in length and require drafts up to 30 feet. Discussion with industry indicated that during the early to mid-1970s, most seismic vessels generally ranged in size from 80 to 150 feet and seldom required drafts of more than 15 feet. Comparison of the total fleet with vessels constructed after 2000 shows the largest increase is associated with design drafts over 20 feet.

9.6.2.7 Liquefied Natural Gas

In addition to its large existing base of crude petroleum, petroleum and chemical products, and dry bulk deep-draft cargoes, the FWOP includes construction of an LNG terminal. Phase I, the terminal is presently in operation, and vessel traffic commenced in April 2008.

The maximum design drafts for existing LNG vessels are 42 feet. The industry standard is for LNG vessels to have 4 to 6 feet underkeel clearance, and the expectation is that LNG vessels will be required to have a minimum of 3 to 4 feet. Underkeel clearance rules on the Freeport Channel are strict; however, the existing vessel sizes and underkeel clearance requirements suggest that channel depths of 45 feet should be adequate, and channel-deepening benefits were not taken for LNG cargo. The docks at the Freeport LNG terminal will accommodate vessels 1,099 feet long by 177 feet wide. This vessel design prompted the non-Federal sponsor to pursue widening of the offshore Outer Bar and Jetty channels from 400 to 600 feet under the Section 204 authority of WRDA 86.

9.6.2.8 Effects of Panama Canal Expansion

Expansion of the Panama Canal is expected to have significant impacts on shipping routes, port development, cargo distribution, and a host of others to the U.S. maritime system. One of its greatest impacts will be felt in the fast-growing container trade where expansion will enable larger vessels to transit the canal. Vessel calls on the East and Gulf coasts are also expected to increase significantly as cargo shifts away from the congested West Coast. Expansion of the canal project is expected to be completed in 2014. The canal expansion will accommodate maximum loaded drafts of 15 meters, or approximately 49 feet. Completion of the Panama Canal improvements is expected to increase the number of larger and fully loaded container and general cargo vessels using Texas Gulf Coast ports.

While it does not appear that refrigerated cargo vessel sizes are increasing, significant increases are occurring for other vessel groups, and completion of the Panama Canal expansion by the year 2014 will allow for more fully loaded vessel movements from deepwater ports in the Far East and the western coasts of Mexico and South America. The canal expansion will affect Freeport chemical exports and the container cargo.

Transportation infrastructure limitations have been cited as contributing to changes in regional distribution of the U.S. container market. Examples of transportation infrastructure limitations and associated effects limiting trade flow were cited in several trade journals. In the 1990s, the use of post-Panamax containerships and the existing constraints at the Panama Canal shifted post-Panamax ships from using the all-water route to using double-stack trains to move goods from West Coast ports eastward.

In addition to greater reliance on rail due to the inability of post-Panamax ships to transit the canal, direct ship movements to the East and Gulf coasts have occurred due to congestion at West Coast ports. At the same time and due to congestion at Los Angeles/Long Beach, some shippers have greatly increased their utilization of the canal, particularly for all-water services from Asia to the U.S. Gulf and East coasts. While there are delays associated with the canal, the delays may be more predictable and easier to plan for than delays at Los Angeles/Long Beach. Increasing costs and decreasing reliability on the U.S. intermodal system, particularly rail connections, and the proliferation of distribution and warehousing centers near ports along the Gulf and Southeast coasts of the U.S., have combined to make the Panama Canal route (also known as the “all-water” route) a more attractive option to shippers serving these markets, particularly those shipping consumer goods in intermodal containers. Effects of shifts in general and container cargo that have taken place in recent years are reflected in Freeport’s base.

From 2001 to 2005, the TEU capacity of containerships transiting the canal increased by 59 percent, the number of containerships transiting the canal rose by 47 percent, and average vessel size increased 21 percent. The Panama Canal Authority was quoted as saying, “by the end of 2011, the total post-Panamax containership fleet will consist of approximately 670 ships with a capacity of almost 4.6 million TEUs, close to double the capacity of the existing post-Panamax fleet."

The Panama Canal Authority used a post-Panamax vessel of 366 meters (1,200 feet) long, 49 meters (161 feet) wide, and 15 meters (49 feet) deep as the reference for establishing the ideal lock chamber sizes. Completion of the Panama Canal widening and deepening is expected to result in increases in Texas container traffic. The expansion of the Panama Canal, with its combination of wider navigation channels and locks coupled with strategic marketing partnerships with key U.S. ports, will increase demand through the canal itself and for ports along the Gulf and East coasts.

9.7 WITHOUT-PROJECT CONDITION

The maximum vessel sizes for crude oil for the existing condition generally do not exceed 120,000 DWT, but Freeport’s 2005 to 2007 historical data include vessels over 150,000 DWT. Vessels up to 175,000 DWT presently use nearby deep-draft projects such as Corpus Christi, Texas City, Houston, and the Sabine-Neches Waterway. The channel widening evaluated under the Section 204 study will allow the range of vessels for the FWOP to increase to 175,000 DWT.

Freeport's recent trade routings and the EIA forecast of imports by country of origin were used to estimate Freeport's 2017 to 2067 trade routing. Under the FWOP and with-project conditions (FWP), imports from origins that include Mexico, Guatemala, Venezuela, Colombia, and Brazil are shipped direct. Under the FWOP imports from Europe, Africa, and the Middle East are either lightered or lightened. For channel depth alternatives of 58 feet or more, the cost of direct shipment for movements from Europe, Africa, and the Middle East is less than that for lightening or lightering. This reduction is expected to result in transition to direct shipment. The "mother vessels" offload partial cargoes to shuttle vessels, and both vessels come into port in the current and future without- and with-project conditions.

For the Lower Stauffer, the FWOP condition is 18 feet. However, it is assumed that the most likely depth that needs to be in place to "call" a new or currently nonexistent operation/facility of concern into existence is between 35 and 40 feet since Houston's container terminals are currently at 40 feet depth. Based on consultation with IWR in 2008 and again in 2011, it was determined that a "threshold depth" of 40 feet was reasonable from which to begin economic incremental analysis. However, the cost of removing the material was calculated based on an existing and FWOP depth of 18 feet.

An off-channel berth area is being constructed in two phases by the non-Federal sponsor. This construction is not part of the Federal project. The transportation savings benefits were calculated based on Phase I of the construction. As part of Phase I, the non-Federal sponsor is constructing a berth area/channel adjacent to the proposed federally constructed Lower Stauffer Channel.

Under the FWOP, the Upper Stauffer Channel would continue to serve OSV vessels. Discussions with channel users and company officials indicated that maneuvering vessels on the silted channel and maintaining a proper alignment for safe passage is hazardous, and this condition is expected to continue. The ability of the channel to serve as a harbor of refuge will deteriorate under the FWOP.

Galveston represents the most likely alternative port for vessel operators that wish to use the Stauffer Channel for layberth and supplies. The FWOP, as well as the FWP, future is characterized by increases in offshore exploration and associated activities. On April 30, 2007, Secretary of the Interior Dirk Kempthorne issued a press release for the previous administration announcing a "major Federal initiative to boost oil and natural gas production on the U.S. Outer Continental Shelf in the Gulf of Mexico and off Alaska. The program could produce 10 billion barrels of oil and 45 trillion cubic feet of natural gas over 40 years, generating almost $170 billion in today's dollars, in net benefits for the Nation."

9.8 PROJECT ALTERNATIVES

The project alternatives include deepening Reach 1 to a maximum depth of 60 feet from its current 45 feet depth, Reach 2 to a maximum depth of 50 feet from its current 45 feet depth, Reach 3 (Lower Stauffer) to a maximum depth of 50 feet from its current depth of 18 feet, and Reach 4 (Upper Stauffer) to a maximum depth of 30 feet from its current depth of 18 feet.

Evaluation of deepening alternatives for the existing 45-foot Project reaches was pursued based on the non-Federal sponsor and industry's interest in bringing in larger and more fully loaded crude petroleum tankers. Project depth alternatives of 55 feet and more were proposed by the non-Federal sponsor as an alternative to offshore transfer of crude petroleum. An advantage that Freeport has over other Texas Gulf Coast ports is that it takes 45 minutes to go from the crude petroleum docks to the offshore jetty. In comparison, it takes a minimum of 3 to 8 hours or more to reach the Gulf of Mexico from other Texas ports.

Increases in Freeport's channel depth provide the opportunity to offload a smaller amount of cargo at sea, thus facilitating the use of smaller shuttle vessels. For channel depths over 55 feet, the cost differential between direct shipment and lightering and lightening is reduced, and this would provide cost incentives for diversions from lightering and lightening to direct shipments for Africa, Europe, and Middle East trade routes.

Improvements to the 36-foot-deep Brazos Harbor Turning Basin were not evaluated due to existing capacity constraints.

Depth alternatives to 50 feet were also evaluated for the Lower Reach of the Stauffer Channel. This would provide an extension from the terminus of the federally authorized 45-foot Freeport Harbor Project.

Depth alternatives up to 30 feet were evaluated for the Upper Reach of the Stauffer Channel. Presently the upper reach of the Stauffer Channel has a water depth of approximately 18 feet.

9.9 TRAFFIC FORECAST

This section presents the tonnage and fleet projections for Freeport's crude petroleum imports, petroleum product imports, chemical exports, and general and containerized cargo. The focus of the traffic analysis was based on identification of vessels and commodities transported in draft-constrained vessels. Therefore, forecasts were not estimated for petroleum product exports and chemical imports. Freeport's chemical product import tonnage showed less than one-half of 1 percent of chemical imports were transported in vessels with design drafts over 45 feet. The small volumes associated with draft-constrained vessels were associated with vessels transporting crude oil, with the chemical cargoes being incidental. Freeport's petroleum product exports showed a similar pattern as with chemical import cargo. Those movements, which generally totaled less than 100 thousand short tons annually, were transported in vessels with design drafts over 45 feet and was included as incidental cargo associated with crude petroleum tanker backhauls.

The forecast of a transition to larger and more fully loaded vessels for petroleum, petroleum products, and chemicals is based on vessel order data, world port development trends, the Panama Canal expansion, and transitions in Freeport's vessel use since the early 1990s. Historical vessel utilization and new vessel orders associated with crude petroleum imports and chemical product exports suggests that portions of these cargoes would transition to larger vessels if increases in channel depth were available. Vessel utilization at comparable ports indicates that the use of larger and more fully loaded vessels is apparent for these cargoes as well. Since the authorization of the existing 45-foot Project depth in the 1990s, the size and draft of vessels using the harbor increased to meet the competitive demand for more-efficient movements. Variables used to help evaluate the transition to more deeply loaded vessels include the percentage of tonnage transported in vessels with design drafts over 40 feet, percentages transported in vessels with loaded drafts over 40 feet, vessel DWT, and parcel sizes. Minimization of transportation cost, given trade route constraints and commodity parcel needs, recognizably drives long-term vessel choices.

The assumption about the use of larger and more fully loaded vessels for products has some uncertainty. Most of the uncertainty is associated with the percentage of cargo anticipated to transition to larger or more fully loaded vessels. However, analysis of Freeport's 1990 to 2007 vessel utilization data and world shipping data, including vessels-on-order for chemical and product carriers and port developments, including the Panama Canal expansion, suggests that there will be some transition to more deeply loaded vessels during the 50-year period of analysis.

Vessel fleets and utilization, and existing and future constraints associated with crude petroleum, petrochemical products, and a new fleet of container vessels provided the basis for identifying the commodities expected to be transported in vessels loaded to channel depths over 45 feet. Foreign port depths and constraints such as the Panama Canal with a present width restriction were additional considerations in the analyses.

9.9.1 CRUDE PETROLEUM IMPORTS

Freeport's crude petroleum tonnage forecast was prepared using Global Insight's September 2010 projections. Table 25 displays Global Insight's September 2008 and 2010 projection in comparison to the Doe's Annual Energy Outlook (AEO) 2008 to 2011 forecasts and Purvin and Gertz's 2009 forecast.

Table 25
U.S. Crude Oil Imports Projection Comparison
Millions of Barrels Per Day

Year	AEO 2008	AEO 2009	AEO 2010	AEO 2011 (Preliminary)	Purvin and Gertz 2009	Global Insight 2008	Global Insight September 2010
2007	10.0	10.0	10.0	10.0	10.0	10.0	10.0
2015	10.2	8.1	9.0	8.9	11.1	n/a	9.6
2025	11.0	6.7	8.8	8.5	12.1	12.4	10.4
2030	11.9	7.0	8.8	8.4	12.5	12.7	10.5
2035	n/a	n/a	8.8	8.7	n/a	12.9	11.0
2040	n/a	n/a	n/a	n/a	n/a	n/a	11.5

Source: U.S. Department of Energy, EIA, *2008 Annual Energy Outlook*, Department of Energy/EIA-0383 (2008), *2009 Annual Energy Outlook*, Department of Energy/EIA-0383 (2009), Table 20, Comparison of Liquids Projections, and *2010 Annual Energy Outlook Early Release*, Table 1, December 2009, *2011 Annual Energy Outlook*, Report Number: DOE/EIA-0383ER(2011), Early Release December 2010. The Global Insight September 2010 forecast was obtained directly for Global Insight; note that the 2008 forecast was obtained from the *2009 Annual Energy Outlook*.

The AEO 2010 values shown were converted from BTUs.

Freeport's crude oil import forecast was prepared by incorporating the Global Insight projections into a regression equation using 1990 to 2009 Freeport imports as a function of U.S. imports. An R Square of 0.922 was produced from the equation. The t-value and F statistic for the equation are significant at statistical confidence levels. Table 26 displays Freeport's regression equation application using the Global Insight forecast results and 1990 to 2009 as a historical base. The results of the base application show an average annual growth rate of 0.9 percent for 2007/2009 to 2040 for Freeport's imports. Freeport's base estimate was used for crude petroleum import calculations.

Table 27 displays the maximum cargo tons by vessel size and channel depth alternatives for representative vessels used in the analysis. An increase in Freeport's channel depth from 45 to 50 feet would allow the existing range of 90,000 to 120,000 DWT vessels to carry approximately 17 percent more cargo. A depth increase from 45 to 55 feet or more would allow the same range of vessels to carry 24 percent more cargo.

Table 28 shows the number of shuttle vessels by channel depth alternatives necessary to offload a VLCC. For offshore lightering of crude petroleum, an increase in Freeport's channel depth would provide opportunities to either reduce the number of shuttle vessels or use smaller shuttles. The use of smaller shuttles reduces the overall cost associated for situations where Suezmax tankers are lightened to channel depth.

Table 26
Regression Equation Data for
Freeport Crude Oil Imports [a/]

Component		Description of Data and Outputs	
Dependent Variable		Freeport Crude Imports (1990–2009)	
Independent Variable		U.S. Crude Imports	
Adjusted R Square		0.922	
No. of Observations		20	
Degrees of Freedom		1	
X Coefficient Level of Significance of t value		1.23418E-11	
F Statistic		226.17	
Significance of F statistic		1.23418E-11	
		Regression Equation Data	
		Base Output	
Constant		–15,902.1	
Standard Error of Y Estimate		1,626.77	
X Coefficient: U.S. Crude Oil Imports		0.068618	
		Freeport (1,000s of Short Tons) 2004–2009	
Historical Year	**U.S. Imports 1,000s of Short Tons[a]**	**Actual**	**Base Estimate[b]**
2005	553,923	22,000	22,107
2006	553,489	21,706	22,077
2007	548,742	18,523	21,752
2008	535,170	20,607	20,820
2009	493,030	19,418	17,929
2007/2009 Average	525,647	19,516	20,937
		Freeport Regression Based Forecast[b]	
Forecast Year	**U.S. Imports[a]**		**Base Estimate[b]**
2017	511,119		19,170
2027	579,813		23,884
2037	613,678		26,207
2040	615,446		27,313
% Average Annual Growth 2007/2009–2040	0.4%		0.9%

Source: USACE, Waterborne Commerce of the U.S. 2005-09 and Global Insight's September 2010 crude oil import forecast.

[a]Calculated using barrel per day volumes from the EIA. The 2005 BPD volume was 10.13 billion. The Global Insight forecast extends through 2040.

[b]Freeport 2027 Imports = –15,902 + (0.0686 * 579,813) with 579,813 short tons being U.S. imports in 2027.

Table 27
Maximum Loaded Cargo

Vessel DWT	Design Draft (feet)	Immersion Factor	Channel Depth (feet)					
			45	50	52	55	58	60
			Maximum Loaded Short Tons of Cargo[a]					
35,000	36	113	35,500	35,500	35,500	35,500	35,500	35,500
50,000	44	141	47,000	50,700	50,700	50,700	50,700	50,700
60,000	46	159	53,000	60,800	60,800	60,800	60,800	60,800
70,000	48	175	59,400	71,000	73,300	73,300	73,300	73,300
75,000	51	183	57,900	70,000	74,900	78,500	78,500	78,500
80,000	53	191	56,000	68,600	73,600	81,200	83,800	83,800
90,000	46	206	82,200	94,200	94,200	94,200	94,200	94,200
100,000	48	220	87,100	101,600	105,100	105,100	105,100	105,100
110,000	50	234	91,800	107,300	113,500	116,600	116,600	116,600
120,000	52	247	96,900	113,300	119,800	128,300	128,300	128,300
135,000	54	266	102,000	119,700	126,700	137,300	144,300	144,300
150,000	56	285	106,000	124,900	132,400	143,700	155,000	160,300
165,000	59	303	108,600	128,600	136,700	148,700	160,700	168,800
175,000	60	314	112,100	132,900	141,200	153,700	166,100	174,400

[a/]Estimated short tons ≅ ((DWT * Maximum % Load) – (Immersion Factor * 12 inches per ton * number of feet light-loaded)).

Table 28
Number of Shuttle Vessels Needed by Channel Depth Alternative[a]

DWT	45	48	50	52	55	58	60
50,000	8	7	7	7	7	7	7
70,000	6	6	5	5	5	5	5
80,000	6	6	6	5	5	5	5
90,000	5	4	4	4	4	4	4
100,000	4	4	4	4	4	4	4
110,000	4	4	4	4	3	3	3
120,000	4	4	4	3	3	3	3
150,000	4	3	3	3	3	3	3
165,000	4	3	3	3	3	3	3
175,000	4	3	3	3	3	3	2

[a]Application of December 2008 Deep-draft vessel operating costs provided by IWR.

9.9.1.1 Crude Petroleum Imports by Trade Route

Freeport's crude oil imports currently include trade routes with physical constraints. The effects of these constraints were evaluated in relationship to Freeport's FWOP and FWP. Freeport's crude petroleum trade routes suggest that the availability of channel depths over 45 feet would provide cost incentives for crude petroleum import tonnage to be transported in more fully loaded vessels. Freeport's crude petroleum imports and the depths at the ports of origin suggest that 95 percent of current tonnage could be loaded to drafts over 45 feet.

A significant percentage of the vessels used for Freeport's direct shipments of crude petroleum imports are loaded to drafts over 40 feet, and channel deepening beyond 45 feet would increase this trend. Long-term expectations are that nearly all of the vessels used for direct shipment could be more fully loaded.

Relatively small tankers are used for crude oil movements from Guatemala, generally with tankers in the 60,000 to 69,999 DWT range. Freeport regularly receives a small volume of Ecuadoran crude oil and occasionally receives crude from the Far East. Shipments from Ecuador are generally transported in Suezmax tankers. Shipments from Ecuador and Guatemala represent less than 1 percent of Freeport's 2002 to 2005 import average. Shipments arriving from Ecuador can be transported either through the Panama Canal or the Trans-Panama Pipeline.

The Panama Canal represents a current restriction for the west coast of South America and Far East routings. While expansion of the Panama Canal will facilitate the use of larger tankers, it will not accommodate the Suezmax tankers presently associated with the U.S. Gulf Coast's current Trans-Panama Pipeline tonnage. Long-term expectations are that the U.S. Gulf Coast's receipt of crude oil from Western South America will be low.

In addition to the current and future Panama Canal limitations, port depth limitations also exist at the Lake Maracaibo ports in Venezuela due to lapses in maintenance dredging. Maintenance dredging has not been performed in several years, and vessels are limited to loaded drafts of approximately 39.5 feet, but the depth limitations at the Venezuelan ports are expected to change over the 50-year period of analysis. According to the EIA (October 2007), production in the Maracaibo basin is declining relative to Venezuela's other production sites. The EIA notes that Venezuela plans to aggressively develop its Orinoco Belt oil resources in the coming years. Ninety-six percent of Freeport's Venezuelan crude oil imports for 2003 to 2005 were from the deepwater port of La Cruz. In 2006, Venezuela consumed 620,000 BPD of oil and exported 2.2 BPD. Currently, the U.S. is Venezuela's major importer. Other new developments include increases in U.S. imports from Brazil.

Generally, it is not cost effective to use vessels larger than 175,000 DWT for direct shipment to Freeport for the range of channel depth alternatives between 48 and 60 feet. However, it is cost effective to load vessels up to 175,000 DWT more fully given the range of depth alternatives between 48 and 60 feet.

It would be cost effective for nearly all vessels used to transport crude petroleum from Mexico and Latin America to be loaded to depths over 45 feet given an increase in channel depth. The percentage of Middle East and Africa movements are subject to greater uncertainty because the logistics associated with offshore transfers introduces higher degrees of uncertainty than direct shipment and, therefore, generates large cost variances.

Vessels over 200,000 DWT are used for some Northern Europe transits associated with offshore lightering operations, in particular the North Sea and Norway movements. The maximum sized vessels used for Nigerian crude oil are principally in the 110,000 to 175,000 DWT range. Most crude imported from the Persian Gulf is shipped in large crude carriers that offload their entire contents onto shuttle vessels. Vessels in the 200,000 to 375,000 DWT range are used for Persian Gulf crude, with most tonnage transported in 300,000 to 350,000 DWT vessels.

The trade route forecast for Freeport's crude petroleum imports is based on analysis of U.S. import forecast and the EIA trade route and world production forecasts. The U.S. trade route forecast includes both ocean-going and pipeline imports.

Canada is the leading supplier of U.S. crude oil, with slightly higher imports than Saudi Arabia. Fifteen percent of 2003 to 2005 U.S. crude petroleum imports came from Canada. Most of Canadian movements were transmitted by pipeline, but there are some ocean-going vessel movements. Freeport's 2002 to 2005 vessel records did not show any Canadian cargo, but U.S. Gulf Coast imports showed some import with low volumes. Freeport's 2006 vessel records showed three vessels with Canadian crude. All three vessels were Suezmax tankers. Freeport's 2006 to 2007 Canadian imports represented 0.3 percent of total imports for each year.

Venezuela constitutes a significant share of Freeport's imports. In comparison to other regions, Freeport has the capacity to refine relatively higher shares of light crude shipped from Venezuela as well as the heavy crudes. Venezuela's long-term reserves are significantly higher than Mexico's reserves.

Brazil has the second largest oil reserves in South America, but its reserves of approximately 12 billion barrels are significantly less than Venezuela's 80 billion barrels. Brazil, along with Kazakhstan, United Arab Emirates, and Libya, were recognized as the U.S. market's fastest-growing crude oil providers. Proven reserves for Kuwait, United Arab Emirates, and Libya are 101, 97, and 41 billion barrels, respectively. Comparatively, proven reserves for Saudi Arabia and Canada are estimated at 262 and 179 billion barrels.

The EIA shows large increases in Brazilian production and imports to the U.S., but Brazil currently remains a net importer of crude. The EIA notes that most of Brazil's imports are from

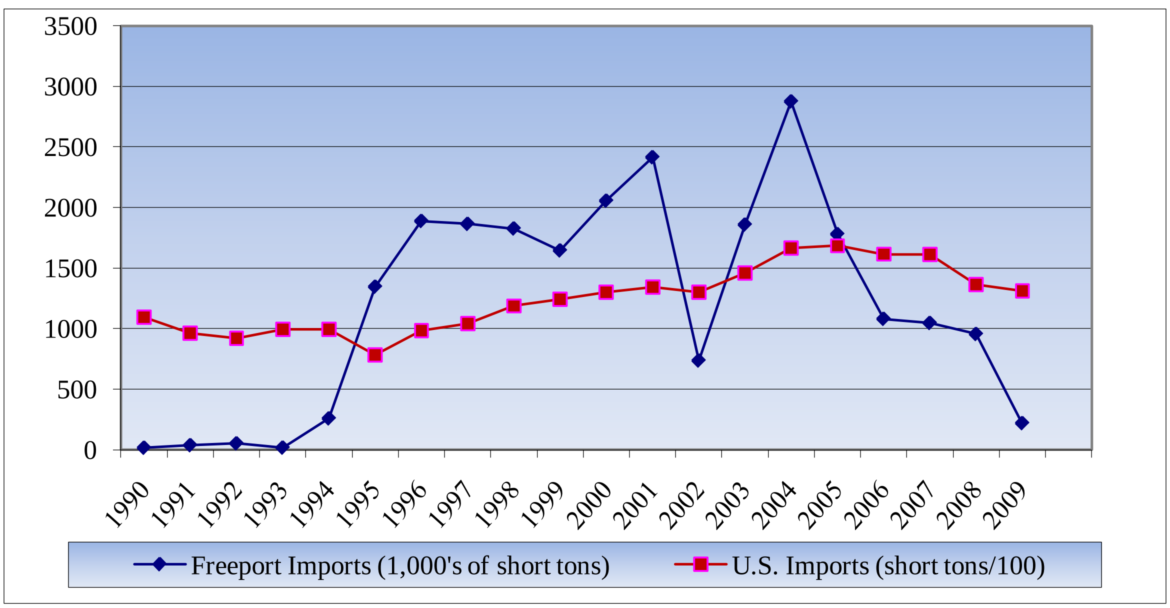
Argentina. Transportation logistics result in Brazil importing crude from Argentina and exporting other crude to the U.S. In 2007, U.S. crude oil imports from Brazil increased by 500 percent over 2006 levels. The EIA shows Brazil's production of conventional fuels increasing at an average annual growth rate of 4.4 percent between 2005 and 2030.

Freeport received a lower share of Mexican crude and a higher share of South American and Caribbean crude compared to the U.S. and Gulf Coast. The 2010-based trade route forecast shows a significant drop in imports from the Middle East. The forecast does not reflect the inclusion of Canadian crude. Future expectations are that the majority of Canadian crude would be transported by pipeline.

9.9.2 PETROLEUM PRODUCT IMPORTS

While experiencing tremendous growth in the early 1990s, petroleum product imports remained relatively constant since the mid-1990s before dropping in 2007, shown on Figure 12. Recent record lows occurred in 2008 to 2009. These lows are associated with drops in gasoline and residual fuel oil imports and parallel national figures but to a much greater extent. Gasoline and residual fuel oil are used for blending and feedstock input in refining crude oil.

Figure 12
U.S. and Freeport Petroleum Product Imports, 1990–2010



Source: USACE, Waterborne Commerce of the U.S. 1990-09.

The 2009 drop in Freeport's product imports relates to an increase in receipt of low-sulphur crude oil from Norway for that year. Low-sulphur crude requires fewer blending components and feedstock inputs than the heavier crudes that Freeport has traditionally imported. The peaks in Freeport product imports relate to years when crude oil imports from Venezuela peaked.

Freeport's 2010 crude oil import data found at the EIA website showed that imports from Venezuela were comparable to 2008[7].

Future expectations concerning the origins of U.S. and regional import volumes of both crude petroleum and sulphur content and subsequent need for blending components and feedstock requirements are subject to a high degree of uncertainty. Recognizing uncertainties, the AEO forecast continues to show imports of partially refined products increasing over the 2008/2009 to 2040 forecast period. Blending components include gasoline, gasoline blending components, jet fuel, and distillate fuel oil. While the AEO forecasts (2009 through the current 2011 early release) shows crude oil imports declining, partially refined products are forecasted to increase to 2008 levels after 2013 and remain steady over the remainder of the forecast period.

Freeport's petroleum product import tonnage forecast was prepared using the AEO 2011 early release projections (December 2010). The AEO 2011 product forecast follows a similar pattern as its 2009 and 2010 projections. Global Insight's September 2010 forecast was also reviewed in preparing Freeport's forecasts.

In general, gasoline and fully finished product imports have historically been concentrated on the U.S. East Coast, with imports to Gulf Coast ports, like Freeport, consisting more heavily of unfinished products. Freeport's imports of gasoline will serve to supplement shortfalls in U.S. refining and continue to be relatively low in comparison to crude petroleum imports. Freeport's imports of partially refined products are expected to experience modest increases after the drop in 2009. Freeport's historical product base consists exclusively of unfinished oils and blending components.

Freeport's product import forecast is a function of the source of crude petroleum. Freeport is expected to continue receiving a steady volume of crude oil imports. This expectation is based on the Conoco Phillips refinery in nearby Sweeny and the extensive network of pipelines from Freeport to other regional and to Midwest refineries. In addition to these movements, crude oil imported to Freeport is transmitted to the Bryan Mound SPR.

9.9.2.1 Petroleum Products Imports by Trade Route

Table 29 shows the 2003 to 2006 trade route distribution for Freeport's petroleum product imports. The 2003 to 2006 petroleum product import trade route distribution consists primarily of imports from Algeria and the Middle East. The future petroleum product import trade route distribution was assumed to include higher volumes of imports from Latin America than presently occurring. This assumption is based on developing trends towards increased investments in refining and based on general informational discussions in the EIA publications.

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[7] Company level details associated with imports by country of origin and sulphur content can be found at the following EIA link: http://www.eia.doe.gov/oil_gas/petroleum/data_publications/company_level_imports/cli.html

Freeport's petroleum product imports for 2002 to 2007 showed that Freeport's more deeply loaded vessels carried lube oil and gasoline. Over 50 percent of Freeport's 2003 to 2005 petroleum product imports were shipped from the Algerian port of Arzew. Nearly all lube oil imports came from Arzew, Algeria. Gasoline is imported from both Algeria and Saudi Arabia. An accommodating depth of 49 to 56 feet is noted in the World Port Index at the oil product terminal in Algeria for crude oil and products. The Arzew refinery is owned by the Algerian national oil company Sonatrach, which owns four refineries in Algeria. Other lube oil refineries in the Mediterranean are located in Alexandria and Port Said, Egypt.

Table 29
Freeport Harbor Petroleum Product Trade Route Distribution
2003–2006 Representative Distribution by Major Trade Route (Percent)

Trade Route	Petroleum Product Imports
Canada	–
Latin America	26.7
Northern Europe, Africa, and Mediterranean	48.9
Middle East and Far East	24.4
Total	100

Sixty-three percent of Freeport's 2003 to 2005 tonnage was transported in vessels with loaded drafts of 39 feet or more and was transported from vessels with channel depths of 43 feet or more. Freeport's crude petroleum trade routes suggest that the availability of channel depths over 45 feet would provide cost incentives for at least 50 percent of petroleum product import tonnage to be transported in more fully loaded vessels. For purposes of analysis, channel-deepening benefits were calculated for 43 percent of Freeport's 2017 to 2027 petroleum product imports and 63 percent of 2037 to 2067 imports.

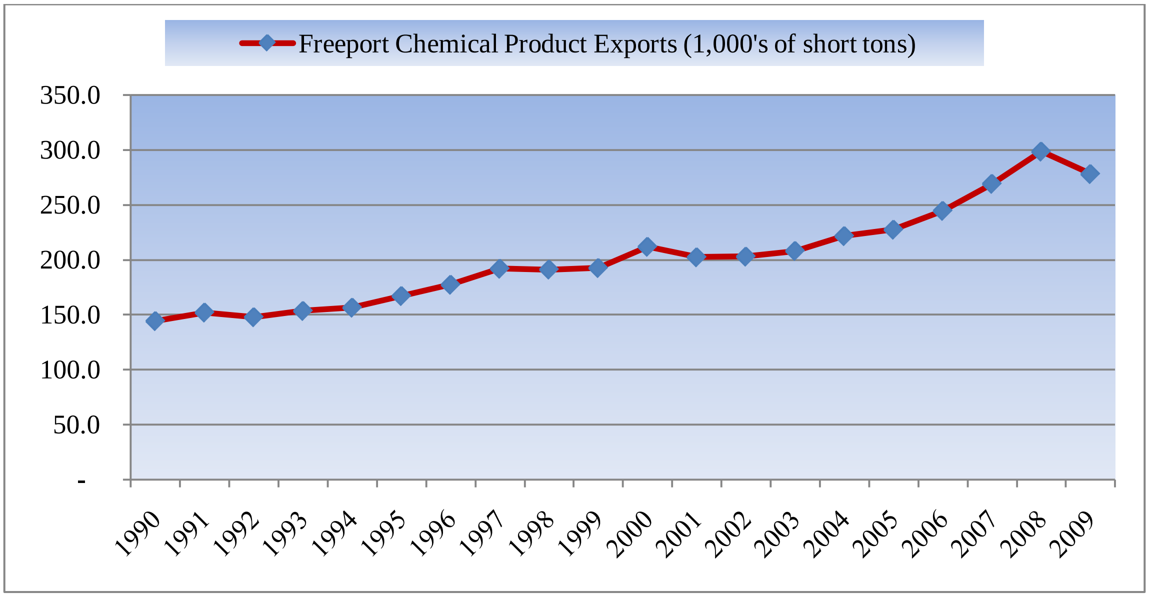
9.9.3 CHEMICAL PRODUCT EXPORTS

Forecast of Freeport's chemical exports were estimated based on analysis of 1990 to 2009 trendline data and the export value-associated industrial materials and supplies. As background, industrial materials and supplies include USACE commodity classifications listed as follows.

- Chemical Products (codes 3110–3299)
- Petroleum Products, excluding crude petroleum (codes 2211–2990)
- Crude Materials (codes 4110–4900)
- Primary Manufactured Goods (codes 5110–5540)
- Farm Products, excluding food (codes 6889–6899)

Figure 13 displays Freeport's exports and the value of industrial materials and supplies. Regression equation outputs for Freeport's 1990 to 2009 chemical exports and the value of U.S. industrial materials and supplies were produced. The trendline of Freeport's exports produced a more conservative forecast than the regression, so the trendline was used for the baseline estimate.

Figure 13
Freeport Chemical Product Exports (1990–2009)



Sources: USACE, Waterborne Commerce of the U.S., Parts 2 and 5, 1990–2009.

Maximum loaded drafts of 36 to 39 feet for Freeport's 1990 and 1993 chemical export tonnage shifted to maximum loaded drafts of 40 to 43 feet for 2002 to 2007 chemical export tonnage. Freeport's vessel utilization patterns from the early 1990s to 2007 show that 5 percent of tonnage was shipped in vessels with loaded drafts of 40 feet or more, up from zero percent in the early 1990s. Recently, chemical exports have exhibited some transition to more fully loaded vessels. Between 5 and 11 percent of 2003 to 2007 chemical exports were transported in vessels with loaded drafts over 40 feet. Chemical vessels on order, the Panama Canal expansion, and the trends in increasing loaded drafts provided the basis for assuming that 14 percent of Freeport's long-term chemical exports will be loaded to drafts of 42 feet or more given the availability of an increase in Freeport's channel depth.

9.9.3.1 Chemical Product Exports by Trade Route

Principal receiving ports include Brazil, Canada, and the Far East. Demand for chemical products is anticipated to remain strong for markets in the Pacific and Brazil, and completion of the Panama Canal improvements in 2014 is expected to result in increases in Freeport's chemical shipments to the Far East. Freeport's chemical exports to Brazil are primarily shipped to the port of Itaqui. There are port development projects taking place at Itaqui and other Brazilian ports. Presently, the maximum channel depth is approximately 43 feet. Port of Itaqui information states that Petrobrás, Brazil's largest industrial company, leases dock facilities at Itaqui. The maximum loaded draft is 19 meters at Itaqui which is equal to approximately 62 feet. The depth at the docks that export steel slab is 59 feet. The largest vessel that can be accommodated at the Canadian port of Port Alfred is presently 40 feet, and there do not appear to be any plans for expansion. Channel depths and dock accommodations at ports in Korea and Singapore are capable of accommodating vessels with loaded drafts over 50 feet. Table 30 shows port depths at major ports receiving chemical products from Freeport.

Table 30
Port Depths at Major Ports Receiving Chemical Products from Freeport, 2003–2005

Region	Port	Country	2003–2005 Total Tonnage for Vessels with Loaded Drafts ≥39 feet		Channel Depth at Chemical Pier (feet)
			Short Tons	% of Total	
Brazil	Itaqui	Brazil	94,895	33.2	59
Northern Europe	Hamburg	Germany	659	0.2	43
Northern Europe	Le Havre	France	6,537	2.3	43
Northern Europe	Terneuzen	Netherlands	19,649	6.9	44
Northern Europe	Rotterdam	Netherlands	43,378	15.2	49
Northern Europe	Antwerp	Belgium	15,629	5.5	62
Middle East/Far East	Merak	Indonesia	9,580	3.3	43
Middle East/Far East	Bombay	India	5,481	1.9	47
Pacific	Yokohama	Japan	8,636	3.0	40
Pacific	Ning Bo	China (Mainland)	24,523	8.6	46
Pacific	Tai Chung	China (Taiwan)	8,355	2.9	46
Pacific	Singapore	Singapore	36,140	12.6	46
Pacific	Kao Hsiung	China (Taiwan)	12,701	4.4	52
Total Tonnage For Vessels With Loaded Drafts ≥39 feet			286,163	100	
% of all 2003–2005 Tonnage for All Loaded Drafts			3.8		

Source: National Imagery and Mapping Agency, 2000 World Port Index, Pub. 150; Lloyd's, World Shipping Encyclopedia, April 2003; and USACE, Waterborne Commerce 2003–2005 detailed records.

The 2003 to 2006 chemical export trade routes consist primarily of Brazil, Northern Europe, and the Pacific. Freeport's 2009 chemical export destinations showed that 20 percent of shipments went to Asia. Transportation cost calculations were estimated using average mileage and the present distribution of ports.

9.9.4 CONTAINER IMPORTS AND EXPORTS

This section presents the analysis of the Federal interest in channel improvement to the lower reach of Stauffer Channel. Work by the non-Federal sponsor on the initial 800 linear feet of dock/1,200 linear feet of berth for Phase I is complete. At this time, the first 20 acres of backland is complete, and the next 15 acres of backland are under construction. The FWOP condition associated with Phase I is based on an off-channel berth area being constructed by the non-Federal sponsor. This berth area is being constructed in two phases and will be as deep as 45 feet; this construction is not part of the Federal project. Phase II includes a total of 80 acres (35 acres as part of Phase I and 45 acres as part of Phase II). The Phase II features include the construction of an additional 1,200 linear feet of berth and 45 acres of backland development to support the additional berth. The schedule is somewhat market-dependent, but it is safe to assume construction of both the additional berth and the backland will be complete by 2016. The plan would be to have the two projects completed concurrent with each other.

Velasco Terminal, Phase I, which includes the first 800 linear feet of wharf and 20 acres of backland, was completed in October 2010. Water access to the terminal requires a 3,000-foot extension from the upper reach of the existing Federal navigation channel. The FWOP condition is based on the non-Federal sponsor, under a permit dredging a 3,000-foot-long berthing channel from an existing depth of 18 feet to an operating depth of 45 feet. This berthing channel is parallel to the existing Stauffer Channel. Based on a FWOP condition depth of 40 feet, optimization of Federal interest in channel depth improvements over 40 feet was subsequently evaluated. For purposes of analysis, the transportation savings benefits for container cargo were calculated from an existing condition depth of 40 feet.

Global Insight expected increases in domestic products after 2010, based on its April 2009 evaluations. Recent gross domestic product (GDP) had a minor decrease in 2009 but now is steadily increasing, and has been helped by an overall increase in exports due to the declining value of the dollar relative to other currencies. Global Insight’s long-term average annual growth rate forecast data are summarized in Table 31. Figure 14 presents Global Insight’s 2006 to 2039 forecast of total expenditures, and Figure 15 presents their GDP forecast.

Over the next 20 years, Texas ports, waterways, highways, and rail facilities will handle between 50 and 85 percent more freight, depending on the mode of transportation, according to “Texas Ports 2007–2008 Capital Program,” a report by TxDOT.

Table 31
Global Insight U.S. Gross Domestic Product Forecast

Average Annual Growth	1976–2006 Historical (%)	2006 ($)	2039 ($)	Average Annual Growth Rate (%)
Gross Domestic Product	3.1	13,178	62,836	4.8
Consumption	3.3	8,029	16,736	4.8
Imports	6.8	1,315	6,452	4.8
Exports	5.9	1,931	7,199	4.8

Source: Global Insight, "The U.S. Economy, The 30-Year Focus," April 2009.

Figure 14
U.S. Total Expenditure Forecast
Billions of Chained 2000 Dollars (2006–2039)

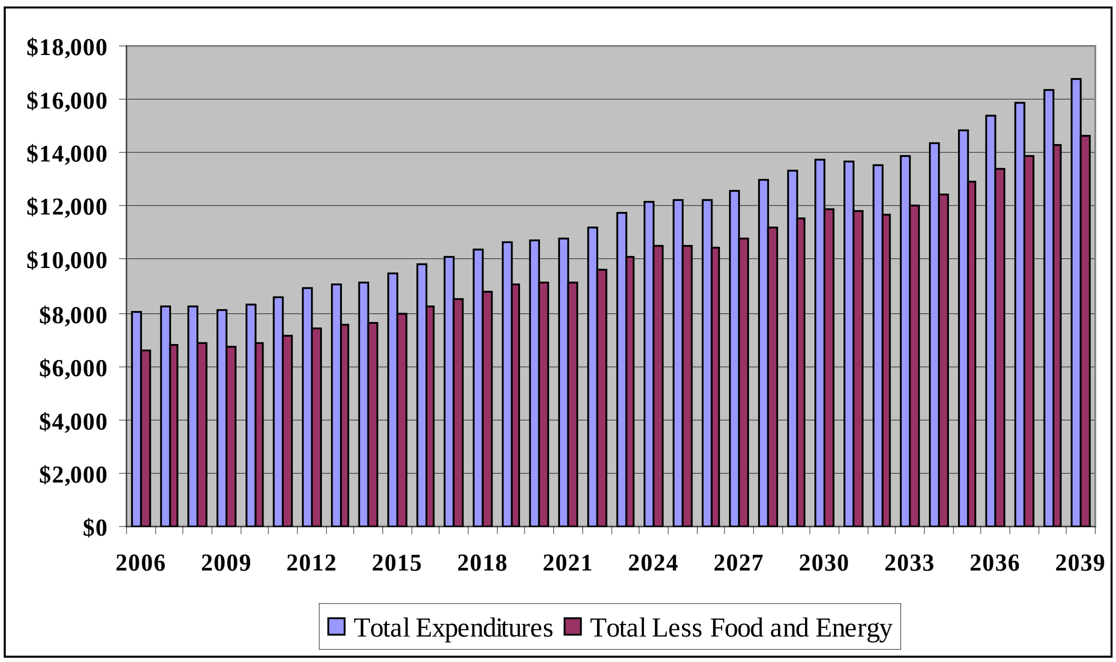
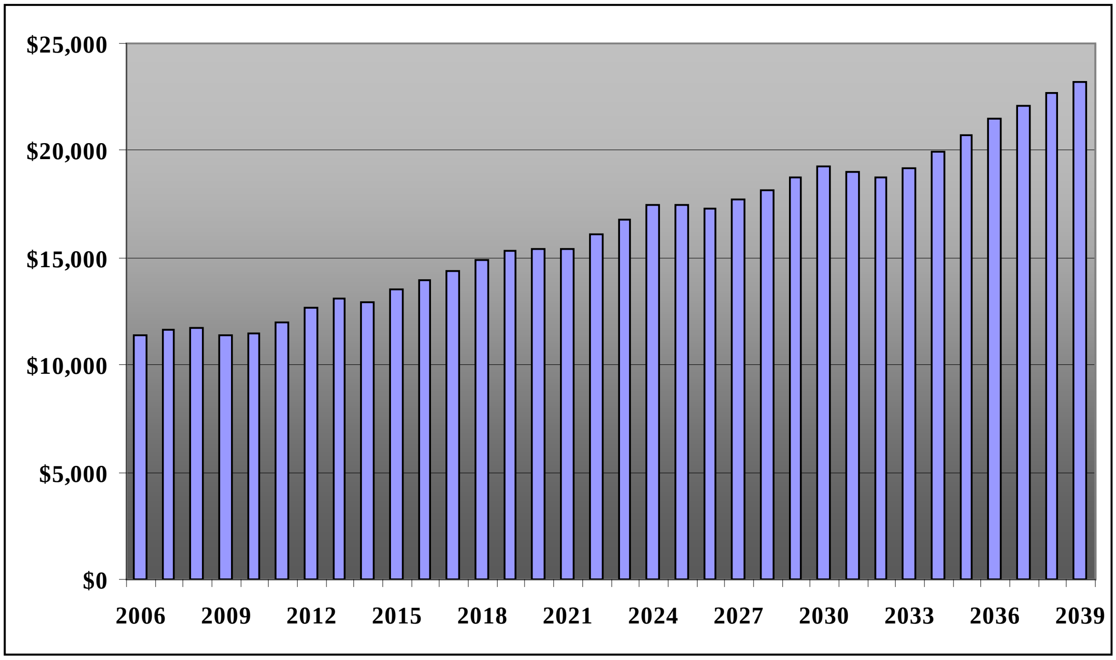


Figure 15
U.S. Gross Domestic Product Forecast
Billions of Chained 2000 Dollars (2006–2039)



Source: Global Insight, "The U.S. Economy, The 30-Year Focus," April 2009.

U.S. demand for imported containerized goods is a function of domestic income, population, exchange rates, and other factors.[8] Demand for containerized exports depends upon economic activity in other countries, exchange rates, and other factors. The geographic pattern of U.S. demand for container port services depends upon (1) the location of domestic consumers with respect to foreign sources for imports, (2) the location of manufacturers, farms, resource industries, and other exporting businesses relative to foreign markets for their goods, and (3) the availability and relative costs of intermodal transport from sources to markets. Several analysts have found a high correlation between population and container volume, particularly imports. While population is one of several variables affecting traffic growth, it is recognizably a key variable particularly for this study region where over 90 percent of existing container tonnage is served by trucks. While the population forecast shows fairly high growth for the region included in the Houston-Galveston-Brazoria Statistical Metropolitan Area, review of 2009 data shows that regional population has increased at higher rates than expected. Population growth for the counties within the Freeport and Houston port areas is presented in Table 32.

[8] University of Rhode Island Transportation Center, Comprehensive Framework for Sustainable Container Port Development for the United States East Coast: *Year One Final Report, October 2001,* P. I-9

Table 32
Houston-Galveston-Brazoria Statistical Metropolitan Area Population Projections
Texas Counties Adjacent to Freeport, Texas

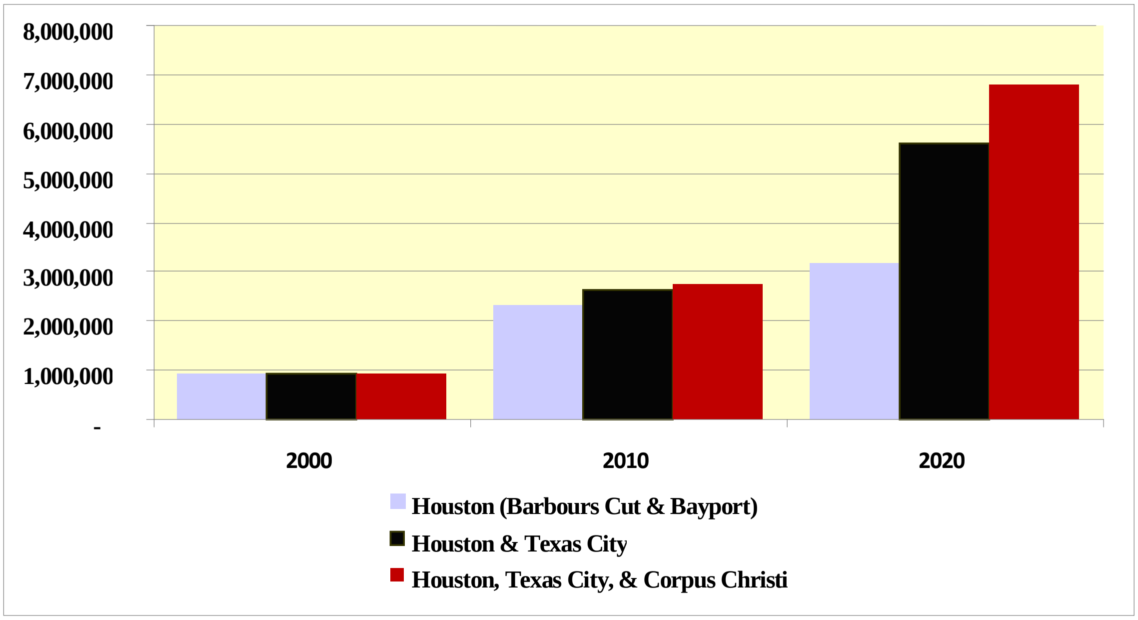
County	2000	2010	2020	2030	2040	2050	2060	Average Annual Growth Rate (%) 2000–2060
Brazoria County	241,767	285,850	331,731	375,664	416,157	459,078	503,894	1.2
Harris County	3,321,660	3,869,179	4,416,793	4,964,463	5,512,168	6,059,895	6,607,635	1.2
Fort Bend	354,452	490,072	630,624	802,486	979,196	1,210,945	1,475,761	2.4
Wharton County	41,188	43,560	46,045	47,647	48,567	48,590	48,074	0.3
Galveston	250,158	268,714	284,731	294,218	298,057	300,915	302,774	0.3
Matagorda	37,957	40,506	43,295	44,991	45,925	45,793	45,377	0.3

Source: Texas Water Development Board, 2006 Regional Water Plan, County Population Projections 2000–2060.

Market demand for an additional U.S. Gulf Coast container terminal, such as Freeport, is a function of ability of competing terminals to meet consumer and producer demand. Figure 16 shows 2000, 2010, and 2020 regional market supply based on terminal availability of Barbours Cut, Bayport, and the potential additions of new terminals in Texas City and Corpus Christi, and a 60 percent expansion of Bayport TEU capacity. The effect of the 2010 market supply levels of 2.3 to 2.8 million TEU shown on Figure 16, and 2010 regional market demand between 2.2 and 2.4 million TEU produced using average annual growth rates of 7.5 and 11 percent indicate that additional capacity is not needed in 2010. However, the effect of the 2020 market supply levels of 4.5 and 7.0 million TEU show insufficient regional container capacity without the planned expansion of Bayport and construction of the Texas City and Corpus Christi terminals. The results of this analysis suggest that the Freeport terminal, which is presently under construction, would fill a market gap in the absence of any of the Bayport expansion and the Texas City and Corpus Christi terminals. The Bayport Container Terminal has plans to be able to handle 2 million TEUs upon full build-out in 2015. Construction of the Freeport terminal indicates that Freeport is poised to capture traffic.

Freeport’s market is expected to complement and supplement Houston’s market. The specific distribution of tonnage by vessel DWT and loaded draft is subject to some uncertainty. Port officials expect that a larger percentage of cargo will be moved in vessels between 40,000 and 68,000 DWT. The base scenario transportation saving benefits for channel depths between 40 and 50 feet were evaluated using Houston’s distribution of container tonnage. Table 33 displays Freeport’s base distribution and alternative distributions as sensitivities. The purpose of the sensitivities was to evaluate the effects of the alternative distributions on depth optimization.

Figure 16
Texas Container Cargo (TEUs) 2000-2020



Source: Compiled from port publications and general literature.

The ERDC ship simulation modeling for Freeport was performed using the 1,138-foot-long by 140.8-foot-wide *Susan Maersk* containership. The results of the modeling revealed that none of the pilots controlling the *Susan Maersk* were able to bring the ship safely into the Brazos Harbor Turning Basin. In order to safely accommodate this vessel, several other improvements to the channel, including widening, would be necessary. Widening would be needed around the Big Bend area inbound from the Seaway Dock at the lower end of the channel in order to accommodate the *Susan Maersk*. While the ERDC modeling showed that the 104,696 DWT *Susan Maersk* could not navigate past Station 180+00, study results indicated that smaller containerships could. Given Freeport's channel dimensions, the ERDC ship simulation results, U.S. Gulf Coast utilization, and world fleet availability, the design vessel for Phase I of Freeport's container terminal expansion is 965 feet long by 106 feet wide.

Table 33 shows the expected container tonnage at Freeport by vessel DWT. This distribution is for South and Central America exports and is based on Houston's distribution. Separate distributions were used for each region for imports and exports. While expectations concerning the distribution for 2017 through 2067 are subject to uncertainty, the general patterns and the shift of larger container vessels to the U.S. Gulf that occurred between 2003 and 2006 are indicative that Freeport's market will receive the larger range Panamax and some post-Panamax containerships on a regular basis. Freeport's market is expected to complement and supplement Houston's market, and the commodity distribution is anticipated to reflect Houston's distribution and the cargo mix is anticipated to consist of a high volume of exports similar to Houston. The base scenario transportation saving benefits for channel depths between 40 and 50 feet were evaluated using Houston's distribution of container tonnage.

Table 33
Expected Container Fleet Distribution by Vessel DWT (South and Central America Exports)

Vessel DWT	Distribution of Freeport's Container Tonnage by Vessel Size (%)		
	Houston Share (Base)	U.S. Share (Sensitivity)	Houston Share Adjusted (Sensitivity)
11,700	15.8	0.0	0.0
18,400	23.1	68.2	32.8
24,300	19.5	23.4	14.7
33,900	9.9	4.6	9.9
45,000	9.9	2.9	4.9
56,800	11.5	0.9	37.7
65,000	2.5	0.0	0.0
74,000	2.5	0.0	0.0
86,000	2.2	0.0	0.0
103,800	3.2	0.0	0.0
Total	100	100	100

The cargo weight is based on traffic data from Houston container ports by region. Freeport's annual tonnage volume is estimated to be approximately 1.9 million short tons in 2017, or 217,000 TEUs, representing 0.3 percent of the U.S. container throughput. Traffic will initially consist of about two vessels per week. Each vessel will drop off and pick up approximately 1,780 TEUs each vessel visit.

The Center for Transportation Research noted that growth of the Velasco site for containers could be aided by a number of factors. The proximity to Barbours Cut and Bayport provides access to a common network of trucking firms, distribution centers, and other port support assets. According to the port, future intermodal activity originating from Freeport will rely on drays to regional yards, specifically Brazoria County. Union Pacific's relocation of its major east-west intermodal yard from Englewood (north of Houston) to the Rosenberg area (in Brazoria County and southwest of Houston) will aid Freeport in offering dray rates that are competitive with Barbours Cut and Bayport.[9]

Although Global Insight projects a 4.8 percent annual increase in container value until the year 2039, this analysis uses an average annual increase in tonnage of 0.2 percent for container vessels, increasing from 1.9 million short tons in 2017 to 2.1 million short tons in 2067.

Construction of Freeport's additional terminal is partly in response to capacity limitations at Freeport's existing facilities located within the confines of the Brazos Harbor Turning Basin. The

[9] Texas Department of Transportation, Texas Rail System Plan, October 2005, p. 2–4. All references to Texas railroad information presented in the USACE report were obtained from the Texas Department of Transportation report.

terminal is also expected to meet increased long-term demand resulting from higher than anticipated regional population growth.

9.9.4.1 Container Imports And Exports by Trade Route

Table 34 displays the routings associated with a limited extraction of vessels using Houston and published in the Journal of Commerce database. The data presented indicate that the first port of call after leaving Houston includes ports as far away as Brazil and Russia. Trade routes are categorized by three regions for imports and exports in the analysis. These regions are South America and Central America, Europe and Africa, and the Mediterranean and Asia.

9.9.5 UPPER STAUFFER

The Mineral Management Service (MMS) 2009 to 2018 U.S. Gulf of Mexico oil and gas forecast shows production potentially peaking at 1.8 million BPD. The MMS full potential forecast is based on offshore production increasing at an average annual rate of 3.1 percent from 2006/2008 through 2018. The U.S. Department of Energy's *2009 Annual Energy Outlook* shows U.S. Gulf of Mexico production growing at an average annual rate of approximately 4.1 percent through 2018 and 2.3 percent from 2006 to 2030. The AEO and MMS forecasts are based on increasingly deep wells. The AEO forecast presented reflects Provisions of the American Recovery and Reinvestment Act.

The transportation savings benefits for the Upper Stauffer Channel were evaluated based on a consideration of the AEO and MMS production forecasts. The average of growth rates of 3.1 to 4.1 percent were used through 2018. These growth rates correspond to the AEO 2006 to 2030 and the MMS 2009 to 2018 production forecasts. For 2018 to 2067, a growth rate of 1 percent was used.

Offshore energy production is potentially one of the largest sources of revenue for the Stauffer Channel. New programs associated with energy independence initiatives have the potential to generate billions of dollars for the area.

It is reasonable to expect Freeport's offshore vessel traffic to increase during the 2017–2067 planning period. An increase in channel depth will result in an increased range of vessel drafts. Channel users estimate that with deeper water they would attract approximately 50 to 60 vessels per year with each vessel returning to dock for fuel and repairs approximately four times per year. An average of 5 vessel movements per week or 30 to 40 OSVs per month will be a reasonable expectation based on the combination of existing traffic and requests and permanent loss of traffic.

Table 34
Containership Vessels by Loaded Draft (Limited Review)

			Routing Sequence (Limited Review)							
TEU	**DWT**	**Vessel Name**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
6732 6402	42,233	*MSC Alessia*	Veracruz	Altamira	Houston	Pt Everglades	Jacksonville	New Orleans	Freeport, Bahamas	Savannah
6402	85,806	*MSC Marina*	Veracruz	Altamira	New Orleans	Charleston	Antwerp			
6402	85,797	*MSC Michaela*	Veracruz	Altamira	Houston	New Orleans	Freeport, Bahamas	Charleston	Norfolk	
5606	72,044	*MSC Marta*	Veracruz	Altamira	Houston	New Orleans	Bahamas	Charleston	Norfolk	
4614	58,943	*Sea-Land Commitment*	Newark	Charleston	Houston	Cagliari, Italy	Gioia Tauro, Italy	Spain		
2728	43,178	*Aramis*	Houston	Colombia	Santa Marta, Cartagena					
–	22,024	*Atlantic Trade*	Houston	St Petersburg	Baltimore					
533	17,850	*Baltic Mercur*	Houston	St Petersburg	New Orleans	Baltimore				
2681	58,548	*CSCL Genoa*	Houston	Miami	Le Havre					
1064	31,507	*Houston*	Houston	Santos						
522	8,077	*Industrial Century*	Houston	Rio de Janeiro	Santos					
390	4,766	*Karin*	Houston	Esmeraldas	Callao, Peru	Pisco, Peru				
4038	52,272	*Libra Mexico*	Altamira	Houston	New Orleans	Buenos Aires	Santos	Rio de Janeiro	Caucedo, Dominican Republic	Veracruz
167	3,504	*Malte B*	Houston	Santa Marta	Cartagena					
1464	43,700	*Star Derby*	Houston	Mobile	Zhangiagang					
1100	30,975	*Yellowstone*	Houston	Altamira	Richards Bay, S. Africa	Durban				
256	2,700	*Baltimar Saturn*	Houston	Esmeraldas	Guayaquil	Callao				
3102	40,638	*CMA CGM Lotus*	Houston	Miami		Le Havvre	Antwerp	Rotterdam	Charleston	
4248	50,869	*Santos*	Altamira	Houston	New Orleans	Buenos Aires	Santos	Rio de Janeiro	Caucedo, Dominican Republic	Veracruz
4253	50,813	*Westfalia Express*	Montevideo	Buenos Aires	Itajai, Brazil	Santos	Houston			

Source: Journal of Commerce, Vessel Itinerary Search, 2008.

For vessels serving offshore rigs, identification of the location of rigs was determined through examination of MMS maps and discussions with Freeport industry representatives. Five travel zones were identified using MMS maps. The MMS maps were used to identify proximity to the Freeport and Galveston area. The MMS maps indicated a base of 175 rigs will be served by vessels operating from Galveston or Freeport. Table 35 shows approximately 92 rigs are in close proximity to Freeport, and 83 are close to Galveston.

Table 35
Number of Offshore Rigs
Freeport and Galveston Vicinity

Zone Description	Freeport	Galveston
Zone A = 20 miles or less	28	22
Zone B = 40 miles or less	41	21
Zone C = 60 miles or less	5	23
Zone D = 80 miles or less	10	3
Zone E =115 miles or less	8	14
Total Rigs	92	83

Source: Compiled from U.S. Mineral Management Service Maps, 2006.

An annual seismic vessel count of 55 was used for the 2008-period base. The seismic vessel count is based on three seismic vessels being in port in March 2009. Three vessels making 6 to 7 return trips results in 19 trips per year.

Cargo vessels presently come in about four times per month for repair or layberth. The port estimates that an annual increase of approximately 95 vessels could occur based on improved access. For the base analysis, an annual count of 48 vessels was used with the expectation of increases over the planning period. For purposes of analysis, Freeport's layberths were assumed to be represented by the Texas Gulf Coast fleet.

Transportation savings benefits were calculated based on 420 supply vessels and 55 seismic vessels saving 4 hours traveling time. The difference in travel time for cargo ships between Freeport and Galveston was found to be primarily represented by the reduction in the number of hours to travel from the open waters of the Gulf of Mexico inward through the Freeport Jetties to the launch/supply service and seismic vessel fueling and repair docks in comparison to travel distance through the Galveston Jetties to similar facilities. The travel time for 48 cargo vessels was estimated to be 2 hours round trip.

9.10 INCREMENTAL ANALYSIS

This section outlines the incremental analysis for the four operational reaches.

The first reach is 45 feet deep and provides access to crude petroleum tankers using docks operated by Seaway and chemical tankers for Dow Chemical. The maximum-sized crude petroleum carrier presently using the Seaway Terminal and the Brazosport Turning Basin is approximately 160,000 DWT. The largest-sized chemical carriers used are presently about 50,000 DWT. An increase in channel depth above 45 feet would allow for the use of larger chemical carriers. The maximum-sized chemical carrier under the FWP is anticipated to be approximately 80,000 DWT.

The second major reach includes ConocoPhillips. The maximum-sized petroleum product carriers used in the reach will not change for the FWP. The largest-sized crude petroleum and petroleum product tankers presently used are 100,000 DWT.

The third reach will include a new container terminal and will complement and supplement Houston traffic. While Houston has some mileage advantages over Freeport for cargo traveling to Dallas/Fort Worth, the comparative one-way distance to San Antonio’s Distribution Centers is less than 5 miles. Therefore, the hinterland is expected to be the same as Houston’s market.

The benefits from an increase in operating depth of 18 feet in the fourth reach were based on reductions in travel time that would lead to improved operational efficiency and economic benefits to the Nation. The benefits analysis is also based on the assumption that current practices of allowing foreign flag vessel access will continue for the 50-year planning period. Advantages Freeport has over other ports are open yard space and permission for vessel operators to work on their own boats. This practice is not normally allowed at other locations. The extra room is an advantage for seismic vessels, which characteristically carry 4 to 5 miles, or about 24,000 feet, of cable. There are only four or five seismic vessels operating in the entirety of the U.S. Gulf, but the Freeport yard is a common destination due to yard space and security.

9.10.1 CHANNEL DEEPENING BENEFITS

The transportation costs and the savings associated with the proposed project depth increase were calculated using commodity-specific vessel class and trade route distributions. Transportation costs were calculated based on the channel depth alternatives and variables associated with vessel design drafts, maximum feet of light-loading, underkeel clearance, mileage traveled, and the number of hours to load and unload. Maximum vessel cargo capacities for crude oil and petroleum products were estimated based on review of the range of load factors obtained from IWR Report 91-R-13, National Economic Development Procedures Manual Deep Draft Navigation, November 1991, and consultation with industry and BRPA. IWR Report 91-R-13 cargo capacity factors published in the deep-draft manual for dry bulk carriers and tankers are shown in Table 36. Consultation with industry and BRPA revealed that these estimates are reasonable. Table 37 displays representative round-trip mileage for the trade routes or junction points used in the transportation cost computations. Table 38 presents the foreign flag double-hull vessel operating cost update used in the analysis. Table 39 presents the container vessel operating costs from IWR's Load Factor Tables. Tables 40, 41, and 42 show the Load Factor tables from IWR for each region for container imports and exports used in the analysis.

Table 36
Adjustments for Estimating Actual Vessel Capacity
Short Tons of Cargo as a Percentage of Vessel DWT

Vessel DWT	% Cargo to DWT
<20,000	90
20,000 to 70,000	92
70,000 to 120,000	95
>120,000	97

Source: USACE, IWR Report 91-R-13, National Economic Development Procedures Manual, Deep-Draft Navigation, November 1991, p. 77 and May 2008 draft.

Table 37
Representative Round-trip Mileage to Freeport Harbor

Origin	Miles
Coatzacoalcos, Mexico	1,360
U.S. Gulf Coast Lightering/Lightening Zone	160
Venezuela	3,934
Panama Canal	3,132
Salvador, Brazil	9,606
Rotterdam, Netherlands	10,318
Sture, Norway	11,172
North Africa, Algiers	10,556
West Africa (Nigeria and Angola)	12,320
Persian Gulf and Indian Subcontinent via Suez Canal	19,472
Persian Gulf and Indian Subcontinent via Cape of Good Hope	24,940
Singapore via Panama Canal	24,248
Singapore via Cape of Good Hope	26,304

Source: Lloyd's Register/Fairplay, Ports & Terminals Guide 2006.

Table 38
Tanker Characteristics and Hourly Operating Cost
Foreign Flag Double-Hull Tankers

DWT	Hourly Operating Cost ($)		
	At Sea	In Port	Base Idle
20,000	947	463	560
25,000	1,008	500	605
35,000	1,135	578	699
50,000	1,292	660	799
60,000	1,460	780	944
70,000	1,552	823	996
80,000	1,644	865	1,047
90,000	1,734	906	1,096
110,000	1,898	971	1,175
150,000	2,216	1,093	1,323
165,000	2,345	1,148	1,389
265,000	3,165	1,475	1,785
300,000	3,436	1,574	1,905
320,000	3,588	1,628	1,970

Source: Application of USACE, Foreign Flag Tanker Costs presented in EGM #11-05, Deep-Draft Vessel Operating Cost May 2011.

Table 39
Foreign Flag Container Vessel Operating Costs

DWT	TEU	LOA	Beam	Design Draft	Immersion Factor	Speed	At Sea Cost	In Port Cost
11,700	800	466	73	26	44	13	578	214
18,400	1,300	535	85	30	59	15	810	292
24,300	1,700	585	90	33	70	14	1,012	360
33,900	2,400	676	99	38	88	16	1,344	387
45,000	3,200	794	106	40	112	18	1,728	425
56,800	4,100	907	106	43	132	18	2,136	490
65,000	4,600	959	106	44	144	18	2,418	540
74,100	5,300	954	132	46	166	17	2,481	525
86,100	6,100	1,018	143	46	195	17	2,775	628
103,800	7,400	1,106	143	48	218	17	3,316	790

Source: IWR Load Factor Analysis, January 2012.

Table 40
Foreign Flag Container Vessel Load Factors (Mediterranean, Asia)

	Imports			Exports		
DWT	Ratio of Cargo to DWT (%)	Maximum Practical Cargo Capacity	Actual Maximum Draft Adjusting for Load Factors	Ratio of Cargo to DWT (%)	Maximum Practical Cargo Capacity	Actual Maximum Draft Adjusting for Load Factors
11,700	63	8,123	24	75	9,692	26
18,400	63	12,772	27	75	15,239	30
24,300	63	16,820	28	75	20,070	30
33,900	63	23,473	33	75	28,008	36
45,000	63	31,165	36	75	37,185	39
56,800	63	39,339	37	75	46,938	40
65,000	63	44,994	39	75	53,686	42
74,100	63	51,307	43	75	61,218	46
86,100	63	59,613	43	75	71,129	46
103,800	63	71,912	45	75	85,805	48

Source: IWR Load Factor Analysis, January 2012.

Table 41
Foreign Flag Container Vessel Load Factors (South and Central America)

	Imports			Exports		
DWT	Ratio of Cargo to DWT (%)	Maximum Practical Cargo Capacity	Actual Maximum Draft Adjusting for Load Factors	Ratio of Cargo to DWT (%)	Maximum Practical Cargo Capacity	Actual Maximum Draft Adjusting for Load Factors
11,700	75	9,692	26	75	9,692	26
18,400	75	15,239	30	75	15,239	30
24,300	75	20,070	30	75	20,070	30
33,900	75	28,008	36	75	28,008	36
45,000	75	37,185	39	75	37,185	39
56,800	75	46,938	40	75	46,938	40
65,000	75	53,686	42	75	53,686	42
74,100	75	61,218	46	75	61,218	46
86,100	75	71,129	46	75	71,129	46
103,800	75	85,805	48	75	85,805	48

Source: IWR Load Factor Analysis, January 2012.

Table 42
Foreign Flag Container Vessel Load Factors (Europe, Africa)

DWT	Imports: Ratio of Cargo to DWT (%)	Imports: Maximum Practical Cargo Capacity	Imports: Actual Maximum Draft Adjusting for Load Factors	Exports: Ratio of Cargo to DWT (%)	Exports: Maximum Practical Cargo Capacity	Exports: Actual Maximum Draft Adjusting for Load Factors
11,700	63	8,123	24	61	7,938	24
18,400	63	12,772	27	61	12,481	27
24,300	63	16,820	28	61	16,438	28
33,900	63	23,473	33	61	22,940	33
45,000	63	31,165	36	61	30,456	35
56,800	63	39,339	37	61	38,445	37
65,000	63	44,994	39	61	43,972	38
74,100	63	51,307	43	61	50,141	43
86,100	63	59,613	43	61	58,258	43
103,800	63	71,912	45	61	70,278	44

Source: IWR Load Factor Analysis, January 2012.

The basic procedure used to calculate transportation costs, using an 110,000 DWT foreign flag tanker as an example, is illustrated in Table 43. Similar computations were made for appropriate distances and vessel sizes for each of the channel depth alternatives.

Table 43
Transportation Cost Calculation (Mexico to Freeport)

Vessel Deadweight Tons (metric tonnes)	110,000	110,000	110,000	110,000	150,000	150,000	150,000	150,000
Channel Depth (feet)	45	50	55	60	45	50	55	60
Design Draft (feet)	50	50	50	50	56	56	56	56
Underkeel Clearance (feet)	3	3	3	3	3	3	3	3
Cargo Capacity (short tons)	116,600	116,600	116,600	116,600	160,300	160,300	160,300	160,300
Cargo Capacity by Channel Depth	91,800	107,300	116,600	116,600	106,000	124,900	143,700	160,300
Immersion Factor (tons per inch)	234	234	234	234	285	285	285	285
Hourly Cost at Sea	1,898	1,898	1,898	1,898	2,216	2,216	2,216	2,216
Hourly Cost in Port	971	971	971	971	1,093	1,093	1,093	1,093
Round Trip Mileage from Mexico	1,314	1,314	1,314	1,314	1,314	1,314	1,314	1,314
Speed (knots)	15	15	15	15	15	15	15	15
Total Voyage Cost ($)	167,400	167,400	167,400	167,400	194,100	194,100	194,100	194,100
Loading/Unloading Rate (short tons/hour)	2,697	2,697	2,697	2,697	2,977	2,977	2,977	2,977
Hours in Port	24	24	24	24	24	24	24	24
Loading and Unloading Cost ($)	74,400	85,600	92,300	92,300	87,200	101,000	114,900	127,100
Pilot and Tug Costs ($)	27,100	27,500	27,700	27,700	41,000	41,400	41,700	42,000
Total Cost Per Ton ($)	2.93	2.61	2.46	2.46	3.04	2.69	2.44	2.27

The resulting costs per ton computations were calculated over the relevant range of vessels projected for each channel depth improvement. The associated savings per ton were measured using the net differences in costs between the existing channel depth and the depth alternative.

9.10.1.1 Crude Petroleum Imports Transportation Savings Benefits

Transportation savings benefits from reductions in the vessel operating costs were calculated based on the relative difference in transportation costs between the FWOP and FWP conditions. Transportation costs and savings were calculated for vessels that minimize transportation costs given trade route constraints and pilot rules. One rule that BRPA emphasized would not change between the FWOP and FWP conditions is underkeel clearance. The FWOP and FWP futures reflect changes in trade routes based on traffic forecast data.

The per ton transportation costs used in estimating the transportation savings benefits correspond to the most likely least cost methods of shipment associated with the particular trade route. As channel depth increases, the cost differential between direct shipment and both lightering and lightening is reduced. This reduction introduces cost incentives for potential shifts from lightering and lightening to direct shipments. An increase in channel depth would probably result in an increase in direct shipment movements for Africa, Mediterranean, Europe, and Middle East shipments.

Table 44 summarizes the transportation cost by trade route used for the FWP and FWOP condition calculations. The weighted average transportation costs were calculated by incorporating a share of mode of shipment to each cost for each channel depth. Given the reduction in the differential between lightening and direct shipment as channel depth increases, an additional variable for preference of direct shipment is used since direct shipment cost is subject to less uncertainty than the offshore transfer processes such as lightering and lightening due to the reduction in transfer times and associated logistics-related delays inherent with offshore transfer.

The cost savings for lightering is lower than direct shipment. The savings for lightering results from increases in shuttle loads due to greater channel depth. The effect of increasing channel depths allows for the reduction in the number of shuttle vessels necessary to totally lighter very large crude carriers. Increases in Freeport's channel depth also provide an opportunity to offload a smaller amount of cargo at sea. The cost calculations are based on relatively efficient transfer times and optimal-sized shuttle vessels. Less than optimal turnaround times would result in a larger differential between the FWOP and FWP condition offshore transfer costs.

In spite of uncertainties associated with changes in methods of shipment, an increase in channel depth reduces the cost per ton for lightering by reducing the number of shuttle vessels used to transport a given volume of crude oil. The savings for lightering movements result from increases in shuttle loads due to greater channel depth in Freeport. The savings for lightened movements result from decreases in offshore unloading time from the mother vessel to shuttles, and the mother vessel is substituting offshore unloading time for dockside unloading time.

Table 44
Freeport Crude Petroleum Imports Transportation Cost and Savings
Most Likely Transportation Mode

Trade Route/Channel Depth	45 feet	50 feet	52 feet	55 feet	58 feet	60 feet
Mexico	Direct	Direct	Direct	Direct	Direct	Direct
most likely cost/ton	$3.32	$2.86	$2.75	$2.61	$2.48	$2.38
savings/ton		$0.46	$0.57	$0.71	$0.84	$0.94
Central and South America	Direct	Direct	Direct	Direct	Direct	Direct
most likely cost/ton	$7.77	$6.84	$6.59	$6.26	$5.83	$5.51
savings/ton		$0.93	$1.18	$1.51	$1.94	$2.26
Africa and Europe	Lighter	Lighter	Lighter	Lighter	Lighten	Direct
most likely cost/ton	$12.90	$12.63	$12.54	$12.31	$12.16	$11.86
savings/ton		$0.27	$0.36	$0.59	$0.74	$1.04
Middle East and Far East	Lighten	Lighten	Lighten	Lighten	Lighten	Direct
most likely cost/ton	$21.14	$20.87	$20.77	$20.54	$20.35	$19.25
savings/ton		$0.27	$0.36	$0.59	$.78	$1.89

The availability of a depth over 55 feet will make the use of Suezmax vessels a cost-effective option for direct shipments for many trade routes. Depths at the shipping origins indicate that constraints at the origin will not be an impediment for most routings.

Table 45 shows the percentage of crude oil imports expected to utilize greater drafts as a result of the cost calculations. Historical data for 2005 to 2007 showed that 96.8 percent of tonnage is shipped in vessels with design drafts over 40 feet, and 61 percent of the tonnage was transported at 40 feet or more. This gap is due to offshore lightering and lightening. The FWOP percentage was assumed to be approximately the same as existing conditions. The FWP benefit calculations are based on approximately 94 percent of tonnage loaded to 40 feet or more.

9.10.1.2 Petroleum Product Imports Transportation Savings Benefits

Reductions in the vessel transportation costs for Freeport’s foreign petroleum product imports were calculated based on the relative difference in transportation costs between FWOP and FWP conditions. As with crude petroleum, transportation costs and savings for product carriers were calculated for vessels that minimize transportation costs given trade route constraints. Again, long-term fleet selection will continue to reflect goals of minimizing vessel operating costs.

Table 45
Freeport Crude Petroleum Imports
Percentage of Tonnage With Draft Constraints

Channel Depth (ft)	% of Tonnage Applied to Benefits			
	Existing Condition[a]	Without-project Future	With-project Future	
			2017–2027	2037–2067
45	61	61	94	94
50	n/a	n/a	94	94
55	n/a	n/a	94	94
60	n/a	n/a	94	94

[a]2003–2007 average.

The effect of channel deepening would allow a portion of the fleet to be more fully loaded. A range of 20 to 63 percent of 2002 to 2007 tonnage was loaded to 40 feet draft or more with an average of 43 percent. The transportation savings from channel deepening was estimated to result in 43 percent of 2017 to 2027 tonnage and 63 percent of 2028 to 2067 tonnage being transported at more fully loaded drafts. The design drafts associated with these shipments ranged from 49 to 54 feet. Table 46 shows the percentage of petroleum product imports expected to utilize greater drafts as a result of the cost calculations.

Table 46
Freeport Petroleum Product Imports
Percentage of Tonnage With Draft Constraints

% of Tonnage Applied to Benefits				
Channel Depth (ft)	Existing Condition[a]	Without-project Future	With-project Future	
			2017–2027	2037–2067
45	33	33	43	63
50	n/a	n/a	43	63
55	n/a	n/a	43	63
60	n/a	n/a	43	63

[a]2003–2007 average.

Table 47 summarizes the annual transportation savings benefits for petroleum product import tonnage. The petroleum product transportation savings benefits were calculated based on vessels from 80,000 to 100,000 DWT. The vessel sizes for existing conditions are the same as those anticipated for the FWOP and FWP futures.

Table 47
Freeport Petroleum Product Imports Benefits ($1,000)

Year	46 feet	47 feet	48 feet	49 feet	50 feet
2017	311	600	869	1,119	1,316
2027	418	805	1,165	1,501	1,766
2037	486	937	1,357	1,748	2,056
2047	515	994	1,439	1,854	2,180
2057	545	1,050	1,520	1,959	2,304
2067	586	1,130	1,636	2,108	2,479
Average Annual Savings (4.0%)	440	847	1,227	1,581	1,859

9.10.1.3 Chemical Product Export Transportation Savings Benefits

The sizes of Freeport's existing chemical carriers range from 22,000 to 50,000 DWT. The design drafts generally range from 42 to 43 feet. Maximum loaded drafts are 40 feet, with 7 percent of 2002 to 2007 tonnage loaded to 40 feet. Lloyd's/Fairplay Vessel Register showed that 2 percent of chemical tankers built since 1995 have design drafts of 42 feet but that less than 1 percent have drafts over 42 feet. The chemical carriers on order as of January 2009 showed that 22 percent have design drafts over 42 feet and 1.6 percent have design drafts over 46 feet. Vessels-on-order records show that the maximum draft for chemical tankers on-order is 48 feet, thereby indicating that transition to larger vessels over the 50-year planning period is likely. The 2002 to 2007 historic data showed an average of 7 percent and a maximum of 11 percent of tonnage transported in vessels with loaded drafts of 40 feet or more, and the design drafts associated these vessel shipments ranged from 40 to 44 feet. The chemical benefits are calculated using 7 percent of 2017 to 2027 tonnage and 14 percent of 2037 to 2067 tonnage.

Table 48 shows the percentage of chemical product export tonnage used in the analysis. The FWOP percentage was assumed to be approximately the same as existing conditions. The FWP percentage is representative of the maximum historical percentage transported at loaded drafts approaching the authorized channel depth.

Table 48
Percentage of Tonnage With Draft Constraints

% of Tonnage Applied to Benefits				
Channel Depth (ft)	Existing Condition[a]	Without-project Future	With-project Future	
			2017–2027	2037–2067
45	7	7	7	14
50	n/a	n/a	7	14
55	n/a	n/a	7	14
60	n/a	n/a	7	14

[a]2003–2007 average calculated from percentages shown in Table 35.

Current draft constrained movements are primarily shipped to Brazil and the Far East. Completion of the Panama Canal improvements is expected to result in increases in Freeport's shipments to the Far East. A trade route forecast was not prepared, so the transportation cost calculations are conservatively based on Freeport's 2002 to 2007 period routings for chemical products exports transported in vessels loaded to drafts of 40 feet or more.

Table 49 summarizes the annual transportation savings benefits for chemical export tonnage. The transportation costs for chemical products were calculated based on vessels from 50,000 to 65,000 DWT for the existing and FWOP conditions. The FWP transportation costs were calculated using vessels from 50,000 to 80,000 DWT. The transition to larger chemical carriers for 14 percent of future tonnage is based on vessels-on-order and vessel deliveries as of July 2006.

9.10.2 Container Transportation Savings Benefits

Increased uncertainty is associated with containers since the Velasco Terminal is currently being built and there are no historical trends at Freeport. Therefore, Houston data were used as a proxy even though Houston's terminals currently have a depth of 40 feet. The vessel sizes vary from 12,000 DWT to 104,000 DWT with the majority of tonnage transported in the 45,000 to 75,000 DWT range. Design drafts generally range from 40 feet to 46 feet, with the large post-Panamax vessels drafting up to 48 feet. Vessels traveling to/from the Mediterranean and Asia carry approximately 50 percent of its tonnage in vessels larger than 65,000 DWT. This tonnage is transported with sailing drafts ranging from 42 to 48 feet. Vessels traveling to/from South and Central America transport approximately 12 percent of its tonnage in vessels larger than 65,000 DWT.

Table 49
Freeport Chemical Product Exports
Benefits ($1,000s)

Year	46 feet	48 feet	50 feet	52 feet	54 feet	56 feet
2017	126	422	626	772	883	981
2027	268	897	1,332	1,643	1,880	2,088
2037	365	1,221	1,813	2,236	2,558	2,841
2047	421	1,410	2,093	2,581	2,953	3,280
2057	478	1,599	2,374	2,927	3,349	3,720
2067	566	1,893	2,811	3,466	3,965	4,404
Average Annual Savings (4.0%)	308	1,030	1,530	1,886	2,158	2,397

9.10.3 Offshore Supply, Research, and Seismic Vessels Transportation Savings Benefits

Table 50 displays the average annual benefits by channel depth for vessels using the Upper Stauffer Channel.

Table 50
Freeport Offshore Supply, Research, and Seismic Vessels Benefits ($1,000s)

Year	20 feet	22 feet	25 feet	28 feet	30 feet
2017	333	753	1,039	1,100	1,111
2027	394	892	1,230	1,302	1,314
2037	466	1,056	1,456	1,541	1,556
2047	552	1,249	1,724	1,823	1,841
2057	653	1,479	2,040	2,158	2,180
2067	773	1,750	2,415	2,554	2,580
Average Annual Savings (4.0%)	455	1,029	1,419	1,502	1,516

9.11 ECONOMIC SUMMARY

This section presents summaries of the transportation savings benefits by commodity group.

Table 51 presents the economic summary data for the first reach. This reach includes the Lower Turning Basin and the Brazosport Turning Basin. The results of the analysis show that the BCR for all channel depth alternatives from 50 to 60 feet are above unity. Of the plans presented, the 60-foot alternative has the highest net excess benefits.

Table 52 presents the economic summary data for the second reach. This reach extends from the Brazosport Turning Basin to the Upper Turning Basin. The 50-foot alternative provides the highest net excess benefits. Channel depths over 50 feet are not included since deepening beyond 50 feet would necessitate significant bank stabilization and dock modifications.

Table 53 displays the results of the base fleet for the third reach. The results of the analysis show that the net excess benefits continue to increase through channel depths of 50 feet. Depths greater than 50 feet were not analyzed because the LPP is 50 feet, and dredging deeper than 50 feet will require dock modifications in Reach 2 and Reach 3.

Table 54 displays the results of the fourth reach. Although the results of the analysis show that the net excess benefits maximize at 26 feet, it was determined that the marginal increase in net excess benefits from 25 feet to 26 feet is not worth the extra cost to the government. Therefore, the Recommended Plan depth is 25 feet.

Table 51
Crude Petroleum for Seaway Terminal and Chemical Products for Dow Chemical (Reach 1)
Average Annual Benefits and Costs (4.0% and $1,000)

Channel Alternative	50 feet	52 feet	55 feet	58 feet	60 feet
2017	10,658	13,799	19,230	24,279	36,566
2027	15,543	20,086	27,831	34,999	51,913
2037	19,668	25,409	35,176	44,193	65,445
2047	24,121	31,161	43,125	54,213	80,062
2057	28,361	36,643	50,719	63,789	94,186
2067	32,758	42,318	58,546	73,611	108,556
First Cost of Construction	169,365	194,926	233,267	290,989	329,470
Interest During Construction	12,105	14,444	17,953	23,488	27,179
Total Investment	181,470	209,370	251,220	314,477	356,649
Average Annual Cost	8,447	9,746	11,694	14,639	16,602
Average Annual O&M[a]	5,784	6,676	8,016	9,160	9,900
Total Annual Cost	14,231	16,422	19,710	23,799	26,503
Average Annual Benefits	18,297	23,647	32,767	41,217	61,125
Net Excess Benefits	4,066	7,225	13,057	17,418	34,622
B/C Ratio	1.3	1.4	1.7	1.7	2.3

Table 52
Crude Petroleum and Petroleum Products
for ConocoPhillips (Reach 2)
Average Annual Benefits and Costs (4.0% and $1,000)

Channel Alternative	46 Feet	47 Feet	48 Feet	49 Feet	50 Feet
2017	590	1,178	1,720	2,246	2,684
2027	813	1,624	2,372	3,098	3,704
2037	983	1,966	2,873	3,755	4,491
2047	1,128	2,264	3,310	4,329	5,184
2057	1,268	2,548	3,728	4,879	5,847
2067	1,420	2,856	4,181	5,474	6,563
First Cost of Construction	40,989	42,036	43,083	44,130	45,177
Interest During Construction	1,182	1,212	1,243	1,273	1,303
Total Investment	42,171	43,249	44,326	45,403	46,480
Average Annual Cost	1,963	2,013	2,063	2,114	2,164
Average Annual O&M	1,400	1,436	1,471	1,507	1,543
Total Annual Cost	3,363	3,449	3,535	3,621	3,707
Average Annual Benefits	906	1,814	2,651	3,465	4,146
Net Excess Benefits	-2,457	-1,635	-884	-156	439
B/C Ratio	0.3	0.5	0.8	1.0	1.1

Table 53
Containers for Velasco Terminal (Reach 3)
Average Annual Benefits and Costs (4.0% and $1,000)

Channel Depth	41 Feet	43 Feet	45 Feet	48 Feet	50 Feet
First Cost of Construction	10,015	10,601	11,188	12,068	12,654
Interest During Construction	118	125	131	142	149
Total Investment	10,133	10,726	11,319	12,210	12,803
Average Annual Cost	472	499	527	568	596
Average Annual O&M	948	965	982	1,007	1,024
Total Annual Cost	1,420	1,464	1,509	1,575	1,620
Average Annual Benefits	535	2,614	5,055	7,325	7,784
Net Excess Benefits	-885	1,150	3,546	5,749	6,165
B/C Ratio	0.4	1.8	3.4	4.6	4.8

Table 54
Upper Stauffer (Reach 4)
Average Annual Benefits and Costs (4.0% and $1,000)

Channel Depth	20 Feet	24 Feet	25 Feet	26 Feet	27 Feet	28 Feet	29 Feet	30 Feet
First Cost of Construction	1,716	3,611	4,085	4,616	5,147	5,678	6,209	6,740
Interest During Construction	3	6	6	8	9	9	10	11
Total Investment	1,718	3,617	4,091	4,623	5,155	5,687	6,219	6,751
Average Annual Cost	80	168	190	215	240	265	289	314
Average Annual O&M	17	37	42	47	52	57	62	67
Total Annual Cost	97	206	233	263	293	322	352	382
Average Annual Benefits	455	1,217	1,419	1,490	1,490	1,502	1,502	1,516
Net Excess Benefits	357	1,011	1,186	1,227	1,197	1,179	1,149	1,135
B/C Ratio	4.7	5.9	6.1	5.7	5.1	4.7	4.3	4.0

A summary of the economic analyses is presented below. The first part of Table 55 shows the NED benefits and the second half shows the LPP benefits. The average annual benefits and costs are based on the current discount rate of 4.0 percent. Table 56 presents the calculations at 7.0 percent.

9.12 REGIONAL ECONOMIC BENEFITS

This section contains discussions and table displays of the regional benefits of port-related activity. The tables and associated discussions are displayed "as presented" in Martin Associates' "The Local and Regional Economic Impacts of Port Freeport." The Freeport regional impact analysis was prepared by Martin Associates for the port of Freeport in 2006.[10] The current report represents an update from an original report prepared in 2003.

The regional benefits contained in the 2006 report and presented here are based on total project effects. While the incremental effects of the Federal action were not calculated, it is generally expected that the proposed deepening project will result in incremental increases beyond the existing base. The expectation that the Federal project will generate increases in regional benefits is based on general conclusions contained in the Martin Associates report that illustrate that Freeport terminal expansions and cargo increases have resulted in increases in jobs, personal earnings, business revenue, and state and local taxes. Additionally, a general observation of multiport analyses is that incremental changes in project depth provide assurances that a port

[10] Martin Associates, "The Local and Regional Economic Impacts of Port Freeport, August 2006,

Table 55
Economic Summary of NED and LPP for Freeport Channel and Stauffer Modification
Average Annual Values (4.0% and $1,000)

	NED Plan			
		Stauffer Modification		
	Freeport Channel 60/50 feet	Lower Reach 50 feet	Upper Reach 25 feet	Totals
First Cost of Construction	374,522	12,664	4,090	391,276
Interest During Construction	28,477	149	6	28,632
Total Investment	402,999	12,813	4,096	419,909
Average Annual Cost	18,760	596	191	19,547
Average Annual O&M	11,258	1,024	42	12,324
Total Annual Cost	30,018	1,620	233	31,871
Average Annual Benefits	65,270	7,784	1,419	74,474
Net Excess Benefits	35,253	6,164	1,186	42,603
B/C Ratios	2.2	4.8	6.1	2.3
	LPP			
		Stauffer Modification		
	Freeport Channel 55/50 feet	Lower Reach 50 feet	Upper Reach 25 feet	Totals
First Cost of Construction	274,988	11,840	3,823	290,652
Interest During Construction	19,156	139	6	19,301
Total Investment	294,144	11,979	3,829	309,953
Average Annual Cost	13,692	558	178	14,428
Average Annual O&M	9,569	1,024	42	10,635
Total Annual Cost	23,261	1,581	221	25,063
Average Annual Benefits	38,442	7,784	1,419	47,646
Net Excess Benefits	15,181	6,203	1,199	22,583
B/C Ratios	1.7	4.9	6.4	1.9

Table 56
Economic Summary of NED and LPP for Freeport Channel and Stauffer Modification
Average Annual Values (7.0% and $1,000)

	NED Plan			
		Stauffer Modification		
	Freeport Channel 60/50 feet	Lower Reach 50 feet	Upper Reach 25 feet	Totals
First Cost of Construction	374,522	12,664	4,090	391,276
Interest During Construction	51,788	262	11	52,060
Total Investment	426,310	12,916	4,101	443,336
Average Annual Cost	30,890	937	297	32,124
Average Annual O&M	11,303	1,015	35	12,353
Total Annual Cost	42,193	1,952	332	44,477
Average Annual Benefits	58,797	7,734	1,312	67,842
Net Excess Benefits	16,604	5,782	980	23,365
B/C Ratios	1.4	4.0	3.9	1.5
	LPP			
		Stauffer Modification		
	Freeport Channel 55/50 feet	Lower Reach 50 feet	Upper Reach 25 feet	Totals
First Cost of Construction	274,988	11,840	3,823	290,652
Interest During Construction	34,733	245	11	34,989
Total Investment	309,721	12,085	3,834	325,641
Average Annual Cost	22,442	876	278	23,596
Average Annual O&M	9,648	1,015	35	10,699
Total Annual Cost	32,091	1,891	313	34,295
Average Annual Benefits	34,564	7,734	1,312	43,610
Net Excess Benefits	2,474	5,843	999	9,315
B/C Ratios	1.1	4.1	4.2	1.3

will, at a minimum, maintain its regional benefit base. A comparative analysis of the effect on total tonnage throughput and vessel utilization among ports would be helpful measuring post-project on a regional and national level. Compilation and comparison of tonnage data among ports could be aggregated relatively easily.

It is recognized that for the communities within the study area, the Freeport Harbor Channel is responsible for benefits to the local and regional economy. Freeport has one of the largest petrochemical complexes in the world. In 2007, Freeport ranked 5th in the nation in terms of foreign trade and 25th in terms of total tonnage. Petroleum and chemical products represent approximately 95 percent foreign trade in 2006.[11] The remaining 5 percent of foreign trade includes bulk materials and agricultural products. Freeport exports 6 percent of U.S. rice and imports 6 percent of U.S. bananas. Approximately 1,700 vessels called at the port in 2006.

Port activities contribute to the local and regional economy by generating business revenues to local and national firms providing vessel and cargo-handling services at the marine terminals. Businesses, in turn, provide employment and income to individuals. The port's marine and cargo terminals and refinery complexes generate revenue throughout the local, state, and national economies. Port facilities include a diverse range of public and private marine terminals. The public marine terminals are those owned by the port and leased to terminal operators and marine terminal tenants. The port's tenants include Dole Fresh Fruit Company, Turbana Corp., Chiquita Brands, Inc., Bryan Coastal Stevedoring, P&O Ports, Vulcan Materials, and American Rice, Inc. The port's general cargo base also includes a variety of temperature-sensitive cargos such as meat and vegetables. P&O, a multinational container terminal operator and stevedore, currently provides container and terminal operations in Freeport for the special requirements of the Dole, Chiquita, and Turbana fruit distributors. Freeport's refrigerated-cargo facility has been in operation since 1984. The port's private marine terminals include Dow Chemical, BASF Corporation, ConocoPhillips Terminal, and TEPPCO Seaway Pipeline Company. In addition to its established base of terminals, the FWOP includes an LNG and a container terminal. The LNG terminal became operational by late 2008 and was constructed by a partnership that includes ConocoPhillips and Dow Chemical. The terminal is located along the northern edge of the Freeport Harbor Outer Bar and Jetty channels near Station 65+00. The port includes an FTZ (No. 149), which was created in 1988. The FTZ provides customs duty deferent and manufacturing and inventory management benefits.

Revenue generated by the port is produced by firms providing services to the commodity and vessel activity at the terminals, revenue from trucking firms, railroads, pipeline operations, terminal operations, and associated refineries and chemical plants (from loading and discharging vessels), handlers, agents, pilots, towing companies, and maritime support firms. This revenue is used to purchase employment (direct jobs), to provide services, to pay stockholders and for

[11] Complete statistics are not available for 2007 as of January 15, 2009. The most recent annual data available from the USACE NDC at the time of report preparation is presented. This report includes the latest annual data available from the USACE NDC.

retained earnings, and to purchase goods and services from local firms, as well as national and international firms. Businesses also pay taxes from their business revenue.

According to the Martin Associates report used in preparation of this section of the report, marine cargo activity at Freeport's public and private marine terminals in the navigation district is responsible for 11,131 direct jobs with local firms. The estimated 11,131 jobs account for nearly $1.1 billion in personal annual incomes. Seventy-five percent of these direct jobs were found to be held by residents of Brazoria County. The activity at the public port facilities is noted to create 970 of the direct jobs. The 10,161 jobs created by the movement of petroleum and petrochemicals at the private terminals are primarily associated with local refineries and chemical plants with private marine terminals. Table 57 shows total direct jobs associated with port activities.

The effect of dry cargo is shown as 0.35 job per 1,000 tons. Again, the incremental effect on jobs and regional income based on the range of channel depths between 40 and 50 feet evaluated for the Lower Stauffer Channel is recognized to be much smaller.

It is noted that in addition to local and regional purchases by those 11,131 individuals holding the direct jobs, an additional 14,700 induced jobs are supported in the regional economy. The report found that 9,886 indirect jobs were supported by $903.6 million of local purchases by businesses supplying services at the marine terminals and by businesses dependent upon the port for the shipment and receipt of cargo. In addition to the direct, induced, and indirect job impacts, an estimated 20,422 jobs in the state of Texas were found to be related to the cargo exported and imported over marine terminals at the port. It is noted in the report that while these 20,422 jobs are considered to be related to port activity, the degree of dependence on the marine terminals is difficult to quantify and should not be considered as dependent on the port as are the direct, induced, and indirect jobs.

Table 58 displays the summary of economic impacts in current 2006 dollars generated by the port's public and private marine terminals as presented in the 2006 Martin Associates document. The report shows that marine activity supported $4.4 billion of total personal wage and salary income and local consumption expenditures for Texas residents. The $4.4 billion income is noted to include $3.4 billion of direct, indirect, induced, and local consumption expenditures, while the remaining $1.0 billion was received by the related port users. The 11,131 direct jobholders received $1.1 billion of direct wage and salary income for an average salary of $95,130. Additionally, a total of $302.9 million of state and local tax revenue was generated by maritime activity at the port, and $93.7 million of state and local taxes was created due to the economic activity of the related users of the cargo moving via the marine terminals.

Table 57
Employment Impact by Sector and Job Category
Number of Jobs

Job Sector	Public Terminals	Private Terminals	Total Jobs
Surface transportation			
Rail	3	56	59
Truck	260	459	720
Maritime services			
Terminal employees/consignees	456	9,541	9,997
International Longshoremen's Association/ dockworkers	100	0	100
Towing	6	14	20
Pilots	3	6	9
Agents	1	7	8
Surveyors/chandlers	1	1	2
Forwarders	54	0	54
Maritime services	8	10	18
Government	24	30	53
Marine construction/shipyards	22	8	31
Barge	0	29	29
Port authority	31	NA	31
Total Jobs	970	10,161	11,131

Source: Martin Associates, "The Local and Regional Economic Impacts of Port Freeport, August 2006, Table II-1, page 21.

The effect on jobs and personal income associated with the Upper Stauffer Channel fall under the marine construction and shipyard activity and appear to provide significant increases in regional income. Vessel traffic on the Upper Stauffer is associated with offshore oilfields and other traffic back and forth to the main segment of the port. Oilfield shipments primarily consisted of fuel, water, supplies, drill pipes, drill mud, and chemicals along with barges and rigs that needed repair. As shown in Table 57, there are 31 jobs associated with marine construction and shipyard activity. The current job count of 31 is considerable less than in the 1970s and 1980s when a channel operating depth of 30 feet was available.

Table 58 shows that Freeport's 2005 marine cargo activity generated a total of approximately $9.0 billion of total economic activity in the State of Texas. Of the $9.0 billion, $936.2 billion, it is noted that bagged rice creates the largest number of direct jobs per 1,000 tons, followed by bulk rice and refrigerated containers. Table 59 presents the job impacts per 1,000 tons for each commodity moving via the public and private marine terminals. The relatively large impact per 1,000 tons for resin reflects the relatively small tonnage handled. Despite the fact that petroleum generated the second largest direct job impact, on a per 1,000 ton basis, petroleum generates 0.05 jobs per 1,000 tons. Dry bulk cargoes, such as limestone, also generate relatively small numbers of jobs per 1,000 tons. The jobs impact per 1,000 tons for chemicals reflects the large number of terminal and plant employees employed by the petrochemical industry in the Freeport Port District that are using private terminals to ship and receive petrochemicals. The finding that the petroleum and bulk cargoes generate relatively small direct jobs per 1,000 tons of throughput reflects the fact that the handling of liquid bulk and dry bulk cargoes is much less labor intensive than handling general cargo, and further, the supporting infrastructure of agents, freight forwarders and customhouse brokers, and warehousing and terminal operators is greater for general cargo such as break-bulk fruit, containerized cargo, and bagged grain. If the dependent shippers/consignees were not included in the direct job impacts per 1,000-ton measure, the difference in the labor intensity of general cargo versus liquid bulk cargo would be even more pronounced.

Table 58
Summary of the Local and Regional Economic Impacts Generated by Port Freeport

Variable	Public Terminals	Private Terminals	Total
Jobs	970	10,161	11,131
Induced	674	14,026	14,700
Indirect	609	9,277	9,886
Related jobs	2,514	17,908	20,422
Total	4,766	51,372	56,139
Personal income ($1,000)			
Direct	39,049	1,019,806	1,058,854
Responding/consumption	67,183	1,754,576	1,821,759
Indirect	28,945	455,596	484,541
Related income	62,600	978,164	1,040,764
Total	197,777	4,208,142	4,405,919
Economic value ($1,000)			
Direct revenue	71,227	864,929	936,156
Local purchases	65,946	837,676	903,621
Related output	354,712	6,838,030	7,192,742
Total	491,885	8,540,635	9,032,519
State & local taxes ($1,000)			
Direct, induced and indirect	12,166	290,698	302,864
Related state and local taxes	5,634	88,035	93,669
Totals	17,800	378,733	396,533

Source: Martin Associates, “The Local and Regional Economic Impacts of Port Freeport, August 2006, Table E-2, page 4.

[t]Totals may not add due to rounding

Table 59
Job Impacts per 1,000 Tons

Commodity	Public	Private	Port-Wide
Dry Containers	0.35		0.35
Reefer Containers	0.68		0.68
General Cargo	0.56		0.56
Resin	0.74		0.74
Bagged Rice	1.00		1.00
Bulk Rice	0.77		0.77
Limestone	0.04		0.04
Breakbulk Fruit	0.42		0.42
Petroleum		0.05	0.05
Chemicals		0.66	0.66

Source: Martin Associates, "The Local and Regional Economic Impacts of Port Freeport, August 2006, Exhibit II-3, page 23.

The port noted that the 2006 Martin Associates report figures reflect substantial gains over those reported in a similar study conducted by Martin Associates in 2003.[12] Specifically, comparison of the 2003 and 2006 reports showed that the number of direct local jobs that rely upon Port Freeport increased by 38 percent, or 3,041 jobs**.** It is noted that the job growth is in part due to expansion of the Dow Chemical operation as well as the growth in cargo, particularly chemicals, general cargo, limestone, and crude petroleum. Since the 2003 economic impact study, the port has experienced a 1.6-million-ton increase of cargo.[13]

9.12.1 Regional Economic Benefits Summary and Conclusions

The Martin Associates report and specific evaluation to the proposed deepening project suggests that incremental increases in jobs as a result of channel deepening would be relatively small. This conclusion is based on the finding that petroleum and bulk cargoes generate relatively small direct jobs per 1,000 tons of throughput since incremental increases beyond 45 feet for the main portion of the Freeport Channel are nearly exclusively associated with petroleum, and benefits for induced tonnage were not included in the benefit calculations. Induced tonnage effects would be minimal due to the large fixed infrastructure associated with petroleum refining and established feedstock requirements as well as regional and national pipeline distribution networks.

While changes in job effects for petroleum will be minimal, the effects associated with the operation of the Velasco Container Terminal will recognizably impact jobs to a greater extent than petroleum. The general effects associated with overall container cargo associated with the

[12] http://www.thefacts.com/downloads/PORT%20FREEPORT%20FINAL_1.pdf
[13] *The Economic Impact of Port Freeport, 2003,* Martin Associates, August 2004

Velasco Terminal should be similar to general cargo and dry containers but would likely not exceed the general cargo effects. General cargo generates 0.56 job per 1,000 tons.

Of the commodities imported and exported at Freeport, petroleum imports contribute the most to national benefits. Benefits from container traffic are the second largest contributor. NED and LPP channel depths, respectively, are 60 feet and 55 feet for Reach 1, 50 feet and 50 feet for Reach 2, 50 feet and 50 feet for Reach 3, and 25 feet and 25 feet for Reach 4. The BCRs for all reaches are above unity in the most likely scenario and most of the sensitivities. Deepening the channel at Freeport will contribute to the local economy and will add value to the national economy.

9.13 SUMMARY AND CONCLUSIONS

Although economies go through periods of peaks and troughs, most stable countries experience long-term growth. The recent recession of the late 2000s caused a setback in the national economy, but the economy of the U.S. is resilient. It is likely to experience growth over the next 50 years. As the national economy grows, demand for energy will also grow. There is debate where this energy will come from, but historical trends have shown that a large portion of the Nation's energy comes from crude petroleum and petroleum products. There are tremendous infrastructure challenges to suddenly divert from these long-term trends. Demand for chemical products and consumer goods are also expected to increase as the economy grows.

Freeport is well poised to capitalize on these increases in demand. Infrastructure is in place, the port has land available for expansion, and Freeport is presently a key contributor to the national economy. One of the National SPRs is nearby, and Freeport is only 3 miles from deep water in the Gulf of Mexico and one hour from one of the largest cities in the country. Of the commodities imported and exported at Freeport, petroleum imports contribute the most to national benefits. Benefits from container traffic are the second largest contributor. Table 60 provides the NED and LPP channel depths and BCRs. The BCRs for all reaches are above unity in the most likely scenario and many of the sensitivities. Deepening the channel at Freeport will contribute to the local economy and will add value to the national economy.

Table 60
NED and LPP Channel Depth Summary

	NED		LPP	
	Channel Depth	**BCR**	**Channel Depth**	**BCR**
Reach 1	60	2.3	55	1.7
Reach 2	50	1.1	50	1.2
Reach 3	50	4.8	50	4.9
Reach 4	25	6.1	25	6.4
Total	-	2.3	-	1.9

10.0 ENVIRONMENTAL EVALUATION OF THE RECOMMENDED PLAN AND PROPOSED MITIGATION

An FEIS that addresses the potential impacts of the Recommended Plan (LPP) upon human and environmental resources was prepared and is appended to this feasibility report. Project impacts are summarized below.

10.1 PHYSIOGRAPHY

The proposed channel deepening and 1.3-mile extension into the Gulf would increase storm surge elevations by about 0.16 foot (5 centimeters) locally, inside the jetties. However, this increase is considered small given the general inundation of the greater Freeport area during a significant storm surge, and will not have a substantial effect on the level of protection offered by the current levee system.

Similarly, proposed project improvements would have only minor impacts on adjacent shorelines for approximately 3 to 4 miles from the Outer Bar Channel jetties.

10.2 TERRESTRIAL AND WETLAND HABITATS

The LPP would require construction of two new upland confined PAs (8 and 9) resulting in the loss of approximately 418 acres of habitat, consisting of 21 acres of riparian forest, 39 acres of ephemeral freshwater wetlands, and 358 acres of grasslands currently used as pasture land. PAs are shown on Figure 17. The Habitat Evaluation Procedure (HEP) was used to model and quantify ecological impacts to develop the project mitigation plan, which fully mitigates impacts to wetlands and riparian forest, as discussed below.

In addition to upland confined placement of new work and maintenance dredged material, dredged material will also be deposited at two existing ODMDSs – the New Work ODMDS and the Maintenance ODMDS. Placement of material at the ODMDSs will result in temporary impacts to aquatic communities (primarily benthos) from increased sedimentation and turbidity. However, these effects are expected to be temporary in nature, and affected benthic organisms and other communities should rapidly recover.

10.3 CLEAN WATER ACT

USACE has received Section 401 State Water Quality Certification for the Recommended Plan. TCEQ has determined that the requirements for water quality certification have been met and has concluded that the placement of fill material will not violate water quality standards. The Recommended Plan is the least environmentally damaging practicable alternative. A CWA Section 404(b)(1) evaluation is presented in the EIS. New work sediments are suitable for use in the proposed upland confined PAs (1, 8, and 9) and for placement in the New Work ODMDS.

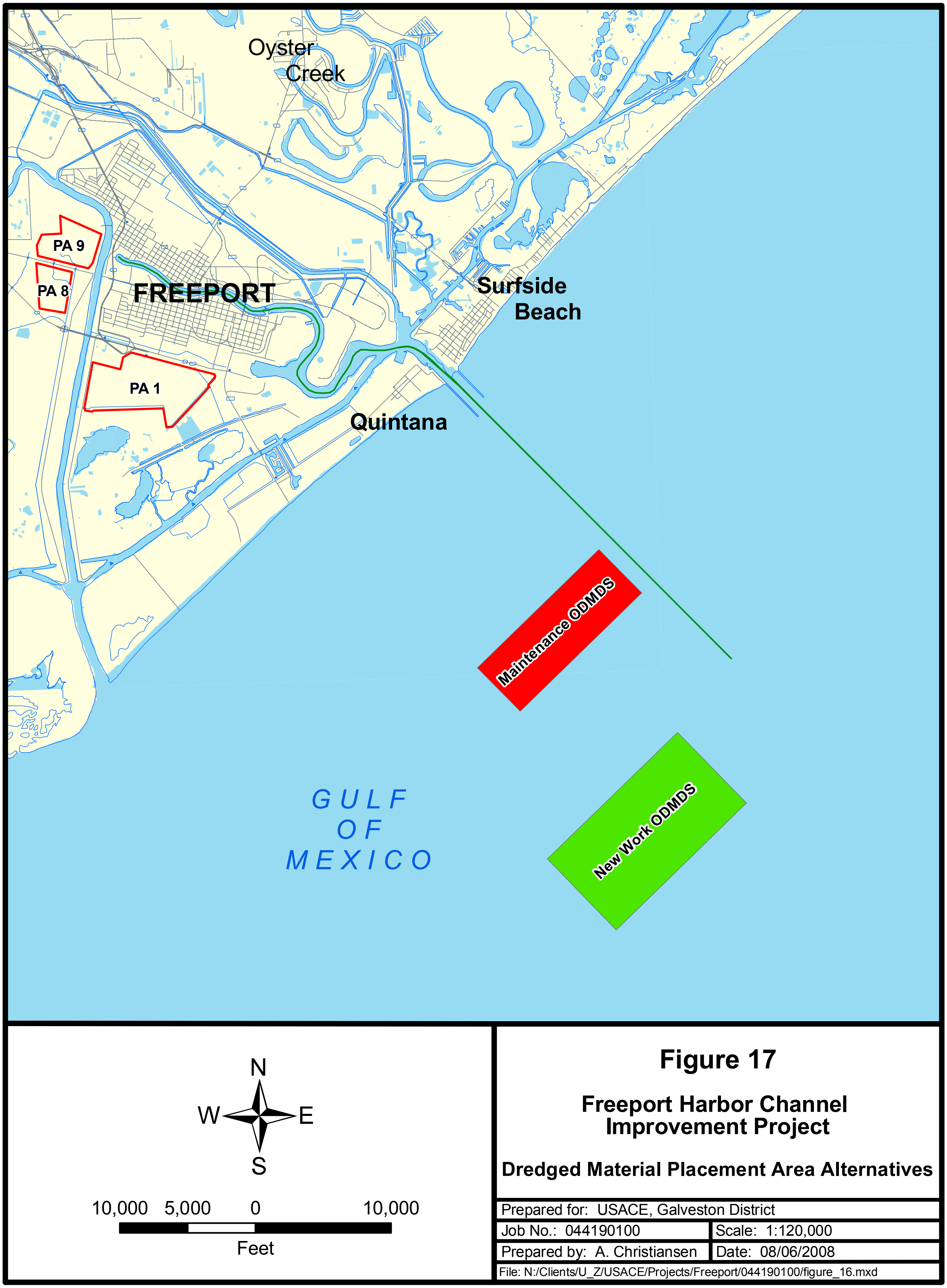


Figure 17

Freeport Harbor Channel Improvement Project

Dredged Material Placement Area Alternatives

Prepared for: USACE, Galveston District	
Job No.: 044190100	Scale: 1:120,000
Prepared by: A. Christiansen	Date: 08/06/2008
File: N:/Clients/U_Z/USACE/Projects/Freeport/044190100/figure_16.mxd	

10.4 MARINE PROTECTION, RESEARCH, AND SANCTUARIES ACT

This Act requires a determination that dredged material placement in the ocean will not appreciably degrade or endanger human health, welfare, amenities, or the marine environment, ecological systems, or economic potential (shellfish beds, fisheries, or recreation areas). Modeling indicates the existing Maintenance and New Work ODMDSs are large enough to accommodate dredged material for the period of analysis of both the Permit Widening and the Federal deepening project. Appendix B of the EIS contains a Marine Protection, Research and Sanctuaries Act Section 102/103 evaluation report for proposed placement activities and an ODMDS Site Monitoring and Management Plan (SMMP). EPA has concurred that the dredged material is suitable for disposal in the ODMDSs and that the SMMP is acceptable.

10.5 MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT

The Magnuson-Stevens Fishery Conservation and Management Act (PL 94-265), as amended, establishes procedures for identifying EFH and required interagency coordination to further the conservation of federally managed fisheries. Consultation with the NMFS has identified EFH in the study area. USACE anticipates only minor and temporary impacts to EFH during construction.

10.6 COASTAL ZONE MANAGEMENT ACT

USACE has evaluated the Recommended Plan for consistency with the Texas Coastal Management Plan and has concluded that it is fully consistent to the maximum extent practicable with the enforceable policies of the Texas program. By letter dated December 15, 2010 (EIS Appendix A-4), USACE requested a review of the Consistency Determination, but to date has received no response.

10.7 FISH AND WILDLIFE COORDINATION ACT

USACE has coordinated with USFWS and TPWD concerning impacts to resources from proposed project improvements. These agencies actively participated in identifying sensitive resources and project impacts, and provided recommendations for the project mitigation plan. USFWS has prepared a Coordination Act Report documenting its recommendations found in Appendix A to the EIS.

10.8 MARINE MAMMAL PROTECTION ACT OF 1972

The Marine Mammal Protection Act is intended to conserve and protect marine mammals and establish the Marine Mammal Commission, the International Dolphin Conservation Program, and a Marine Mammal Health and Stranding Response Program. The Recommended Plan is in compliance with this Act. Proposed project improvements are not expected to impact any marine mammals as they are unlikely to occur in the project area.

10.9 COASTAL BARRIER IMPROVEMENT ACT OF 1990

There are two Coastal Barrier Improvement Act (CBRA)–designated areas near the project area**:** Follets Island Unit T04 and Brazos River Complex T05/T05P. Exceptions to the Federal expenditure restrictions of the CBRA include construction of improvements(s) to existing Federal navigation channels and related structures (e.g., jetties), including the disposal of dredged material related to maintenance and construction. Thus, the Recommended Plan is exempt from the prohibitions identified in this CBRA.

10.10 FARMLAND PROTECTION POLICY ACT OF 1981 AND THE COUNCIL ON ENVIRONMENTAL QUALITY MEMORANDUM PRIME OR UNIQUE FARMLANDS

Construction of PA 9 will impact approximately 250 acres of prime farmland. The NRCS calculated the Farm Conversion Impact Rating to be a total of 161. The Farmland Conversion Impact Rating of 161 makes the tract for PA 9 subject to the FPPA. However, the project alternatives analyses identify no other practicable alternatives for the placement of dredged material from this project. Accordingly, in compliance with NEPA and pursuant to the FPPA, the project has properly considered a wide range of possible alternatives.

10.11 EXECUTIVE ORDER 11988, FLOODPLAIN MANAGEMENT

This Executive Order (EO) directs Federal agencies to evaluate the potential effects of proposed actions on floodplains. Such actions should not be undertaken that directly or indirectly induce growth in the floodplain unless there is no practical alternative. The Recommended Plan includes the development of two new PAs within the Brazos River floodplain. Alternatives to avoid the adverse effects of developing these PAs in the floodplain were evaluated, and it has been determined that this is the only practicable alternative.

10.12 EXECUTIVE ORDER 12898, ENVIRONMENTAL JUSTICE

In compliance with EO 12898, an evaluation of potential Environmental Justice (EJ) impacts was completed and is presented in the EIS. The Recommended Plan is not expected to adversely affect low-income or minority populations.

10.13 CLEAN AIR ACT

The project study area is located within a severe nonattainment area for ozone. As described in the EIS, new work dredging activities associated with the LPP are expected to exceed the NO_X

conformity threshold of 25 tons per year. Based on the General Conformity Concurrence letter provided by TCEQ, a Final General Conformity Determination was prepared by the USACE. TCEQ and USACE's determination of conformity is based on conformance with the currently approved Houston-Galveston-Brazoria area SIP and the emissions information and project schedule proposed at the time. Once a final project schedule is completed in the PED phase, USACE will provide an update of the General Conformity documentation to TCEQ and EPA for final review and concurrence.

10.14 NOISE

During construction, noise impacts during dredging operations would be about 3 to 6 dBA (A-weighted sound level) higher at the nearest noise receptors than what is experienced during current maintenance dredging. Construction would be essentially equivalent to increased noise levels currently heard during maintenance dredging.

10.15 HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE

An HTRW assessment revealed that no known regulated sites or hazardous materials exist within the LPP project footprint. Additionally, historic and current sediment data for the existing channel indicate no contaminant concerns. It should also be noted that proposed improvements would remove new work material consisting primarily of clay, which is highly impermeable to contaminant migration, located beneath existing maintenance overburden. Based on this information, HTRW is not expected to be encountered during proposed channel improvements.

10.16 THREATENED AND ENDANGERED SPECIES

USACE has determined that construction activities utilizing hopper dredges may adversely affect but are not likely to jeopardize the continued existence of several endangered sea turtle species. Consultation with NMFS under Section 7 of the Endangered Species Act (ESA) has been initiated. A draft BA describing potential impacts on these listed species is presented in the EIS. A new Biological Opinion (BO) from NMFS is anticipated for the project. It is expected that the new BO will institute reasonable and prudent measures to avoid sea turtle impacts, and it may establish new incidental take limits for construction.

10.17 CULTURAL RESOURCES

Historical research and investigations identified a potentially National Register–eligible Civil War–period site near PA 9. Further investigation of the Civil War site will be addressed under the conditions of the PAg executed for this project. Compliance with the PAg places the project in compliance with the National Historic Preservation Act.

10.18 CUMULATIVE IMPACTS

Cumulative impacts have been evaluated based on existing and reasonably foreseeable projects in the Freeport area, ranging from existing waterways such as the GIWW, to new ship channel industries such as an LNG facility, construction of a new containership berth and a marina, and construction of other industrial and commercial facilities. Total cumulative impacts from these projects are not expected to adversely affect human health, socioeconomic well-being, or the environment of the project area.

10.19 PROJECT MITIGATION

Construction of the two new upland PAs 8 and 9 would result in both wetland and riparian forest impacts. The PAs would be developed on land owned or leased by the non-Federal sponsor and will contain approximately 33 mcy of new work and maintenance material from the proposed channel improvements. Impacts to these areas were evaluated using HEP and IWR-Plan to develop a project mitigation plan. The proposed PAs are currently degraded pasture with ephemeral wetland swales that are seasonally dry, and some second-growth riparian forest adjacent to the Brazos River Diversion Channel (Diversion Channel). The pastures are overgrazed and contain substantial numbers of non-native invasives including pasture grasses and Chinese tallow trees (tallow), and native species indicative of disturbance.

Construction of PAs 8 and 9, including pipeline corridors and effluent ditches, would impact 418 acres of land, including 21 acres of secondary riparian forest, 39 acres of ephemeral wetlands, and 358 acres of degraded pasture with some scrub/shrub. Of these habitats, mitigation is proposed for the riparian forest and wetland impacts.

Resource agency personnel from USFWS and TPWD participated in site visits and in collecting the required field data for conducting the HEP analysis for impacted wetlands and riparian forest, and provided valuable advice in completing the analysis. The agencies also provided significant input for siting and design of project mitigation features. During agency coordination for siting project mitigation features, emphasis was placed on in-kind mitigation located in close proximity to impacted habitats. Areas considered for project mitigation and coordinated with the resource agencies included land to the north and east of PA 9 adjacent to the Diversion Channel, and land east of PA 8 to the Diversion Channel (see Figure 17). The area between the proposed PAs and the Diversion Channel contains riparian forest and areas suitable for wetland mitigation.

The agencies made a number of recommendations USACE could not concur with for project mitigation. For example, USFWS recommended that the entire riparian forest between the PAs and the Diversion Channel be selectively cleared of tallow, replanted with a combination of hard mast and flood-tolerant native trees, and be protected in perpetuity by a conservation easement. As demonstrated below, however, this would have resulted in excessive mitigation for project impacts and will not be implemented.

TPWD requested preservation in perpetuity of a 5-acre ephemeral wetland swale located between PA 8 and SH 36 as a mitigation feature. However, the port does not wish to make this property available for project mitigation. The resource agencies also requested mitigation for the 358 acres of pasture impacted by PAs 8 and 9. The agencies classify these pastures as wet coastal prairie. USACE does not concur with this habitat classification. Although the land at one time may have been coastal prairie, it is now degraded grassland planted to and primarily consisting of non-native pasture grasses of limited wildlife habitat value that does not merit mitigation.

A project mitigation plan to address unavoidable impacts to significant habitat resulting from the construction of PAs 8 and 9 was developed that satisfies the USACE's cost effectiveness and incremental cost analysis (CE/ICA) requirements as outlined in ER 1105-2-100, Appendix C. The plan considers the quality and regional significance of the impacted habitats and focuses on mitigating impacts to high-quality habitat while minimizing additional land acquisition costs. HEP models were considered adequate for both the riparian forest and wetland habitats impacted by this project. Once unavoidable project impacts had been identified, several tracts of land owned by the port were considered for mitigation—Peach Point and lands surrounding PAs 8 and 9. Peach Point is located west of Freeport near Jones Creek and consists primarily of tidally influenced wetlands near the GIWW. These wetlands would not provide acceptable mitigation because they are out-of-kind mitigation substitutes for the freshwater, ephemeral wetlands impacted by the project and were not considered further. Two additional sites near Peach Point were also considered for mitigation, but were dropped because they too would have provided out-of-kind mitigation like Peach Point. The port-owned lands adjacent to PAs 8 and 9 provide for in-kind, on-site mitigation, which is desirable. In addition, the port is willing to grant a conservation easement that will protect the riparian forest mitigation tract in perpetuity. A detailed evaluation of these lands based on HEP modeling is documented below. HEP modeling was used to quantify project impacts and mitigation compensation. CE/ICA was also performed to identify an optimal mitigation plan that fully compensates for project impacts.

10.19.1 Habitat Evaluation Procedure

A HEP analysis was used to determine the amount of mitigation required to compensate for project impacts. HEP uses evaluation species as representative of habitat quality by determining a Habitat Suitability Index (HSI) for each species using a particular habitat. Each species has an associated HSI model, which is based upon the assumption that a positive relationship exists between the HSI and habitat carrying capacity, and that habitat suitability can be summarized on a scale ranging from 0.0 to 1.0 (USFWS, 1996). Data from field measurements of habitat variables is run through the respective suitability index model to generate a baseline HSI for each species or group of species utilizing the same habitats.

The number of habitat units (HUs) available in the habitat is calculated by multiplying the HSI by the area of habitat being analyzed. The final step in the process is to project the condition of the habitat into the future, over the period of analysis, and determine what the value of the habitat will be at certain points in time (target years [TYs]), when a change in habitat conditions is likely to occur. HUs are then summed for each species and divided by the years in the period of analysis.

The foregoing procedure provides the average annual habitat units (AAHUs) that can be compared to the AAHUs calculated for the same habitat type and species at different locations or different conditions (management plans) at the same location. AAHUs for the FWP and FWOP conditions are calculated in this manner. The difference between these two conditions is used to calculate project impact and determine the mitigation needed to compensate for habitat losses to the evaluation species.

10.19.2 Site Description and Selection of Evaluation Species

PA 8 is utilized as a pasture. The site retains perhaps 30 percent of its original prairie habitat function and value and is vegetated by a large number of non-native invasives and species indicative of pasture maintenance, such as mowing. Species found at the site include rattlebox, Gulf cordgrass, St. Augustine grass, sedges, and tallow. Sparse concentrations of seacoast sumpweed, Carolina wolfberry, marsh-hay cordgrass, and sea-ox eye daisy were also observed. Evidence of overgrazing exists. PA 8 also contains two small stock ponds. At the time of the site visit, these ponds were dry and vegetated with common arrowhead, seacoast sumpweed, and tallow and were surrounded by Gulf cordgrass, marsh-hay cordgrass, and scattered native flowers.

PA 9 is adjacent to the Diversion Channel, and although similar to PA 8, is drier and the ground cover is sparser. The majority of the site consists of heavily overgrazed pasture vegetated with bermudagrass, rattlebox, frog fruit, and scattered Gulf cordgrass. The pasture retains perhaps 10 percent of its original prairie habitat function and value and is considered substantially degraded. It also includes two areas of riparian forest totaling 21 acres, both of which are situated adjacent to the Diversion Channel. The riparian forest is an open, second-growth, mixed-species forest, approximately 40 years in age, with a grazed understory. The forest consists of a diverse range of non-native invasive and native tree and brush species including sugar hackberry, cedar elm, tallow, toothache tree, pecan, red mulberry, gum bumelia, yaupon, palmetto, and other species. The height of this mixed-species canopy reaches 35 feet, and its density, maturity, diversity, and location along the Diversion Channel near the Gulf of Mexico add to its value as a neotropical migrant songbird “fallout” site.

Wildlife species include the northern bobwhite, marsh harrier, black-shouldered kite, great egret, snowy egret, great blue heron, eastern meadowlark, red-winged blackbird, and others. Species seen in the forested portion of PA 9 included the red-shouldered hawk, black-crowned night heron, northern mockingbird, northern cardinal, white-eyed vireo, tufted titmouse, and common blackbird.

For purposes of habitat evaluation, the HSI models for the mottled duck and great egret were used. These species served as surrogates for calculating the quality of the ephemeral wetlands at PAs 8 and 9. Ephemeral wetland swales at these sites generally consist of a semipermanent water regime, with water depths possibly approaching 3–5 inches during wet winter months and drying up during the summer months.

Two evaluation species, the gray squirrel and veery, were used as surrogates to calculate the quality of the riparian forest. The eastern meadowlark was used as an evaluation species for calculating the quality of the grasslands, and only the HSI value for the food component of its model was used in the HEP analysis.

While the gray squirrel, veery, and mottled duck were not observed in the riparian forest or wetland habitats during site visits, the forest may support squirrels and could provide fallout sanctuary for the veery. Similarly, the mottled duck could use the stock ponds and ephemeral swales and potholes within the project area.

Field measurements were collected by USACE assisted by USFWS and TPWD biologists at PAs 8 and 9 on December 4, 2006. Data were collected from representative sampling sites in the riparian forest and at wetland and grassland areas to assess the suitability of these habitats for their respective evaluation species. The initial field data collected from this site visit was compiled by USFWS to establish baseline HSI values for the evaluation species, and was reviewed by TPWD and USACE.

10.19.3 HEP Modeling

10.19.3.1 Future Without-Project

Table 61 provides the average baseline condition HSI values and HUs for each evaluation species in each of the three habitats. The HSI was obtained by averaging the HSI values for each of the habitats surveyed. Before performing calculations for AAHUs, anticipated changes that will occur in the quality or quantity of each habitat were determined and expressed as TYs, over the designated period of analysis, which is 50 years for this project.

When determining the TYs for the FWOP condition, it was assumed that the forest habitat on PA 9 would not likely experience any meaningful changes (losses) in habitat quality or quantity resulting from tree removal or other activities for development.

Table 61
Average HSI Values and HUs for All Habitats in Project Impact Areas
(Baseline Conditions)

Evaluation Species	Area of Available Habitat (Acres)	Average HSI Values	Habitat Units
Forest			
Gray Squirrel	21	0.21	4.4
Veery	21	0.47	9.9
Average HSI:		0.34	7.14
Wetlands			
Mottled Duck	39	0.13	5
Great Egret	39	0.29	11.3
Average HSI:		0.21	8.15
Grasslands			
Eastern Meadowlark	358	0.39	139.6

Currently, the forested areas function in part as a buffer for Dow operations and, according to Port Freeport, will continue providing that function. Also, the current use of grasslands as maintained pasture for cattle would likely continue. However, the wetland and grassland habitats on PA 8 are expected to experience a change in habitat value for each evaluation species for the FWOP condition, due to planned development actions by the port on Tract Eight. According to port officials, these changes would probably occur approximately 15 years into the future. Prior to this potential development timeframe, the wetlands and grasslands on PA 8 are assumed to experience no change in habitat value for each evaluation species.

In general, the assumption of no change in wetlands for both PAs 8 and 9 is due to their control by the port and Dow. No change to the grasslands is expected because they are maintained pasture and periodically mowed, preventing any meaningful successional change.

The final step in calculating the AAHUs for each habitat is to calculate the HUs contained in a habitat for each evaluation species at each target year, and summing all HUs to get cumulative HUs. The cumulative HUs are then divided by the period of analysis (50 years) to derive the AAHUs, which can be compared with similar habitats in a mitigation plan to ensure adequate compensation for project impacts (losses). Table 62 presents the HUs calculated for the evaluation species in each habitat, the cumulative HUs for all evaluation species in a habitat, and the AAHUs for the FWOP condition.

Table 62 shows that without the project in place, the forests will retain a habitat value of approximately 7.46 AAHUs for the two evaluation species over the 50-year period of analysis. The wetlands and the grasslands will have approximate values of 1.1 and 67 AAHUs, respectively.

Table 62
Future Without-Project AAHUs in Evaluation Species' Habitats

Habitat	Species	Target Years (TY) Compared	Acres	HSI Values	Habitat Units Between TY	Average Annual Habitat Units
Forest	Gray Squirrel and Veery	$TY_1 - TY_0$	21	0.34	7.14	
		$TY_{15} - TY_1$	21	0.46	81.20	
		$TY_{25} - TY_{15}$	21	0.55	74.23	
		$TY_{51} - TY_{25}$	21	0.58	210.50	
Cumulative Habitat Units:					373.07	
AAHUs:						7.46
Wetlands	Mottled Duck and Great Egret	$TY_1 - TY_0$	39	0.21	9.2	
		$TY_2 - TY_1$	39	0.20	9.00	
		$TY_{15} - TY_2$	16	0	39.36	
		$TY_{51} - TY_{15}$	16	0	0	
Cumulative Habitat Units:					57.56	
AAHUs:						1.15
Grasslands	Eastern Meadowlark	$TY_1 - TY_0$	358	0.39	138.7	
		$TY_2 - TY_1$	358	0.39	138.7	
		$TY_{15} - TY_2$	358	0.39	317.5	
		$TY_{51} - TY_{15}$	213	0.40	2,755.0	
Cumulative Habitat Units:					3,350.0	
AAHUs:						67.0

10.19.3.2 Future With-Project

The next step in the HEP analysis involves calculating the AAHUs for each habitat with the dredged material disposal action in place. Because the analysis examines only the construction areas where dredged material placement will occur, resulting in displacement of all surface features (habitats), we would expect that the AAHUs for this condition will be very low. At the end of TY_1 when project construction terminates and when project features are in place, the habitat will not recover, so no HUs exist from this point through the period of analysis, which is 50 years with the project features in place. The AAHUs are calculated using the same formula as in the FWOP analysis, and the results are presented in Table 63.

Table 63
Future With-Project AAHUs in Evaluation Species' Habitats

Habitat	Species	Target Years (TY) Compared	Acres	HSI Values	Habitat Units Between TY	Average Annual Habitat Units
Forest	Gray Squirrel and Veery	$TY_1 - TY_0$	21	0.34	2.38	
		$TY_{15} - TY_1$	0	0	0	
		$TY_{25} - TY_{15}$	0	0	0	
		$TY_{51} - TY_{25}$	0	0	0	
Cumulative Habitat Units:					2.38	
AAHUs:						0.047
Wetlands	Mottled Duck and Great Egret	$TY_1 - TY_0$	39	0.21	3.15	
		$TY_2 - TY_1$	0	0	0	
		$TY_{15} - TY_2$	0	0	0	
		$TY_{51} - TY_{15}$	0	0	0	
Cumulative Habitat Units:					3.15	
AAHUs:						0.063
Grasslands	Eastern Meadowlark	$TY_1 - TY_0$	358	0.39	46.3	
		$TY_2 - TY_1$	0	0	0	
		$TY_{15} - TY_2$	0	0	0	
		$TY_{51} - TY_{15}$	0	0	0	
Cumulative Habitat Units:					46.3	
AAHUs:						0.93

As expected, with project implementation, the AAHUs are greatly diminished compared to the FWOP condition. AAHUs for the FWP conditions range from 0.047 for the forest habitat, to 0.063 for the wetlands, and 0.93 for the grasslands.

10.19.3.2.1 Proposed Mitigation Strategies For Forest and Wetlands

To determine the amount of new habitat required for compensating project impacts to riparian forests and wetlands, the AAHUs for each habitat in the FWOP condition are subtracted from the AAHUs for each habitat in the FWP condition. Based on this calculation, the approximate AAHUs, which are all negative, required in the new habitats to offset project losses are:

- Riparian Forests: 7.41
- Wetlands: 1.1

Three sites located on project lands adjacent to the proposed PAs were selected for project mitigation planning and were used for developing the CE/ICA. The CE/ICA identifies the most-cost-effective plans for accomplishing the required levels of mitigation at these sites. The three alternative mitigation sites and their associated measures are:

Mitigation Site 1

Riparian and wetland mitigation – riparian forest area north of PA 9 and adjacent to pasture area bordering the forest's southern edge. This 131.8-acre site includes 117 acres of riparian forest, 5 acres of cleared forest, and about 9.8 acres of grassland. It is large enough for both wetland and riparian mitigation features and is supported by the resource agencies as a mitigation site because it will be protected by a conservation easement. Field surveys revealed that approximately 10 percent of the riparian forest in Mitigation Site 1 (11 acres) is composed of tallows. Riparian mitigation at this site would consist of clearing the tallows, primarily around natural openings in the forest, and planting native trees. After clearing, the openings would be planted with a variety of small hard-mast and flood-tolerant native seedlings or sapling trees to enhance the existing forest. Additionally, 1 acre of these native tree species would be planted around the perimeter of a proposed wetland creation area, described below. A total of 12 acres of new native trees would be planted for riparian mitigation at this site, and the entire 117-acre riparian forest would be preserved as part of the proposed project mitigation plan.

Wetland mitigation would be accomplished by creating a 3-acre ephemeral wetland (pond) in the grassland area of Site 1. The pond would be sloped to reach a maximum center depth of about 12 inches, the limit of accessibility of the mottled duck, and will have areas of between 4 to 9 inches in depth as required by the great egret for wade feeding. A variety of wetland plant species plugs (submerged and emergent) would be planted on 5- to 6-foot centers on the slopes and water's edge of the pond at different elevations, dependent upon the aquatic plant species, for a medium-density planting.

Mitigation Site 2

Riparian mitigation – riparian forest located east of PA 9. This 14.5-acre site includes 9.5 acres of riparian forest and 5 acres of mixed tallow and scrub/shrub vegetation. The 5-acre tallow and scrub/shrub area would be cleared and planted with small hard-mast and flood-tolerant native seedlings or sapling trees for riparian forest mitigation.

Mitigation Site 3

Riparian and wetland mitigation – riparian forest located east of PA 8. This 124.7-acre site includes 112 acres of riparian forest and 12.7 acres of very dense tallow stands and scrub/shrub. Riparian forest mitigation would be accomplished by clearing tallows from 30 percent (33 acres) of the 112-acre riparian forest. This 33-acre area would then be planted with small hard-mast native and flood-tolerant seedlings or sapling trees. Additionally, 1 acre of native trees would be planted around the perimeter of the proposed wetland creation area at this site, for a total of 34 acres of newly planted trees. A 3-acre ephemeral wetland area (pond) would be created within the scrub/shrub area of the site. The same design features and aquatic planting scheme proposed at Site 1 for pond creation would be used.

Native tree and wetland vegetation that could be used for mitigation planting include water oak, willow oak, overcup oak, pecan, green ash, planar tree, water hickory, bald cypress, black willow, red maple, smart weed, common or soft rush, sawgrass, sedge, pickerel weed, Gulf cordgrass, and swamp lily.

10.20 COST EFFECTIVENESS AND INCREMENTAL COST ANALYSIS

10.20.1 Forest Mitigation

Sufficient acreage exists between mitigation sites (sites 1, 2, and 3) for planting a mixture of tree species to compensate for project losses. To determine the AAHUs the mitigation forest and mitigation wetlands contain, certain TYs representing the time of expected change in habitat values were chosen to measure the gains in habitat value over the 50-year period of analysis. Habitat gains will be reflected in AAHUs calculated for each evaluation species as the trees mature.

10.20.1.1 Scales

Two scales of trees were considered for planting at the sites: seedlings and saplings. For seedlings, a mixture of tree species would be utilized. The seedlings would be 0.5 to 1 inch in diameter, 2 to 4 feet tall, planted at a density of 150 trees per acre, and spaced as forest openings permit. Tree mortality for this size is expected to approach 30 to 40 percent over the 50-year period of analysis, with most of the mortality occurring within the first 2 years after planting. The more-expensive saplings would range between 1.5- to 2-inch-diameter plants, 5–7 feet in height, and be planted at a density of 40 trees per acre as forest openings permit. Mortality for this size tree is expected to approach 25 percent over the 50-year period of analysis, with most of the mortality occurring within the first 2 years after planting.

In a straight cost comparison, the seedlings are less expensive than the saplings, but the saplings are expected to provide value to the forest habitat earlier due to their size. While the larger and more-expensive saplings may initially provide a faster recovery of the forest habitat compared to seedlings, the differences between these two tree sizes with respect to their contribution of value to the existing forest would be negligible over the 50-year period of analysis. Therefore, both tree sizes are deemed to provide the same habitat value, and this was reflected in the HEP analysis by assigning them both the same HSI scores.

A review of the variables that influence habitat quality for the two forest evaluation species revealed that the most important variables common to these species are:

- Percent canopy closure of trees that produce hard mast, which are greater than or equal to 10 inches diameter at breast height;
- Percent of tree canopy closure;
- Number and diversity of tree species that produce hard mast; and
- Soil moisture regime.

10.20.1.1.1 Assumptions Using Seedling Trees

The variables listed above for the evaluation species were used to identify the TYs for the HEP analysis. While growth is highly variable among species and even among individuals of the same species, it is not unreasonable to expect some of the faster growing trees, such as the oaks, to achieve large crowns that could easily approach 25–30 feet in diameter within 20 years. Therefore, with a mixture of species in the plantings and about a 25–30 percent mortality rate, it is not unreasonable to expect a 40–60 percent canopy closure in about 25 years.

Using all the above assumptions, the habitat value was calculated for each evaluation species, and a cost for mitigation for each site was developed. Table 64 presents the FWOP and projected FWP HSI values for each species for each target year used in the analysis. It also displays FWOP AAHUs at each of the proposed sites, and projects FWP mitigation AAHUs for the proposed sites, if the planting scheme for seedlings was implemented.

10.20.2 Wetland Mitigation

Sufficient acreage is available at all proposed mitigation sites, except for Site 2, for wetland creation. Site 2 will not be considered for any wetland habitat creation due to reasons stated earlier.

In determining the AAHUs the mitigation wetlands contain, certain TYs representing the time of expected change in habitat value were chosen to measure the gains in habitat value over the 50-year period of analysis. Habitat gains will be reflected in AAHUs calculated for each evaluation species as the wetland vegetation matures.

As described earlier, a medium-density planting scheme was chosen for wetland mitigation. This scheme would consist of planting mixed wetland plant species and is thought to be most cost effective.

Table 64
AAHUs for Forest Species at Proposed Mitigation Sites
FWOP vs. FWP Mitigation*

Site 1 (Seedlings) Gray Squirrel and Veery	**Target Years (TY) Compared**	**Acres (FWOP)**	**HSI Value (FWOP)**	**Habitat Units Between TYs (FWOP)**	**Average Annual Habitat Units (FWOP)**	**Acres (FWP)**	**HSI Value (FWP)**	**Habitat Units Between TYs (FWP)**	**Average Annual Habitat Units (FWP)**	**AAHUs Gained at Site 1 (FWP minus FWOP AAHUs)**
	$TY_1 - TY_0$	117	0.34	39.78		117	0.34	39.9		
	$TY_{15} - TY_1$	117	0.47	460.8		118	.55	507.6		
	$TY_{25} - TY_{15}$	117	0.56	425.8		118	.66	499.7		
	$TY_{51} - TY_{25}$	117	0.6	1204		118	0.75	1469.6		
AAHUs:					42.6				50.3	7.73
Site 2 (Seedlings) Gray Squirrel and Veery	**Target Years (TY) Compared**	**Acres (FWOP)**	**HSI Value (FWOP)**	**Habitat Units Between TYs (FWOP)**	**Average Annual Habitat Units (FWOP)**	**Acres (FWP)**	**HSI Value (FWP)**	**Habitat Units Between TYs (FWP)**	**Average Annual Habitat Units (FWP)**	**AAHUs Gained at Site 2 (FWP minus FWOP AAHUs)**
	$TY_1 - TY_0$	9.5	0.34	3.2		9.5	0.34	4.0		
	$TY_{15} - TY_1$	9.5	0.25	27		14.5	0.35	48.3		
	$TY_{25} - TY_{15}$	9.5	0.36	20.4		14.5	0.46	41.1		
	$TY_{51} - TY_{25}$	9.5	0.40	64.2		14.5	0.52	126.1		
AAHUs:					2.3				4.39	2.09
Site 3 (Seedlings) Gray Squirrel and Veery	**Target Years (TY) Compared**	**Acres (FWOP)**	**HSI Value (FWOP)**	**Habitat Units Between TYs (FWOP)**	**Average Annual Habitat Units (FWOP)**	**Acres (FWP)**	**HSI Value (FWP)**	**Habitat Units Between TYs (FWP)**	**Average Annual Habitat Units (FWP)**	**AAHUs Gained at Site 3 (FWP minus FWOP AAHUs)**
	$TY_1 - TY_0$	112.7	0.07	7.8		112.7	0.07	7.9		
	$TY_{15} - TY_1$	112.7	0.08	81.7		113.7	0.25	175.8		
	$TY_{25} - TY_{15}$	112.7	0.10	71.0		113.7	0.40	260.0		
	$TY_{51} - TY_{25}$	112.7	0.11	214.0		113.7	0.55	959.1		
AAHUs:					7.49				28.0	20.51

*FWOP = future without-project; FWP = future with-project

10.20.2.1 Assumptions Using a Medium-density Wetland Planning Scheme

The mottled duck is more dependent in the HSI model on the density of potential nesting and brooding sites. The variable of most importance to the great egret at the mitigation sites is the availability of feeding habitat, consisting of substrate zones with 4–9 inches of water depth, covered by submerged or emergent vegetation.

Many factors affect the amount of time required for a created wetland to become functional. However, existing data suggest that most aquatic plant species are fast growing and will achieve coverage and density equivalent to naturally occurring wetlands after about 2 years, which is the assumption used for the proposed medium-density planting scheme.

Based upon hydrologic evaluation of the proposed project, it is anticipated that the grasslands and/or forest surrounding the ephemeral pond would periodically flood, but inundation of the ephemeral pond and fringing area proposed for planting would likely not exceed 5 days' duration in any flood event. The suggested plants, once established, can tolerate this duration of flooding without significant impacts to their growth and use for wildlife. Using these assumptions, the habitat value was calculated for each evaluation species and a cost of mitigation for each site was developed. Table 65 presents the FWOP and projected FWP HSI values for the evaluation species for each target year used in the analysis. It also displays FWOP AAHUs at each of the proposed sites, and projects FWP mitigation AAHUs for the proposed sites, if the wetland creation scheme was implemented.

10.20.3 IWR-PLAN

IWR-PLAN software was used to perform a cost analysis of the proposed woodland seedling-tree planting and the wetland aquatic planting schemes at each of the proposed, alternative mitigation sites. The software identifies combinations of mitigation measures that produce alternative plans that are cost effective and/or incrementally justified. Plans are identified as cost effective or as Best Buy plans, which are also cost-effective plans. IWR-Plan analyzed each of the proposed mitigation sites and measures and generated 27 possible plan combinations. A total of four cost-effective and four Best Buy mitigation plans were identified and are presented in Table 66. Table 67 provides incremental costs for Best Buy Plan combinations.

IWR-Plan results indicate that implementation of the woodland seedling and wetland planting schemes would be a Best Buy Plan at one individual site, and also leads to additional Best Buy plans when other sites are combined. To fully compensate for project impacts to riparian/hardwood forests and ephemeral wetland habitats, 7.41 and 1.1 AAHUs, respectively, were required for mitigation.

Table 65
AAHUs for Wetland Species at Proposed Mitigation Sites
FWOP vs. FWP Mitigation

Site 1 (Wetlands) Mottled Duck and Great Egret	Target Years (TY) Compared	Acres (FWOP)	HSI Value (FWOP)	Habitat Units Between TYs (FWOP)	Average Annual Habitat Units (FWOP)	Acres (FWP)	HSI Value (FWP)	Habitat Units Between TYs (FWP)	Average Annual Habitat Units (FWP)	AAHUs Gained at Site 1 (FWP minus FWOP AAHUs)
	$TY_1 - TY_0$	0	0	0		3	0.13	0.13		
	$TY_2 - TY_1$	0	0	0		3	0.45	0.87		
	$TY_3 - TY_2$	0	0	0		3	0.71	1.74		
	$TY_{51} - TY_3$	0	0	0		3	0.79	72.9		
AAHUs:					0				1.5	1.5
Site 3 (Wetlands) Mottled Duck and Great Egret	**Target Years (TY) Compared**	**Acres (FWOP)**	**HSI Value (FWOP)**	**Habitat Units Between TYs (FWOP)**	**Average Annual Habitat Units (FWOP)**	**Acres (FWP)**	**HSI Value (FWP)**	**Habitat Units Between TYs (FWP)**	**Average Annual Habitat Units (FWP)**	**AAHUs Gained at Site 3 (FWP minus FWOP AAHUs)**
	$TY_1 - TY_0$	0	0	0		3	0.13	0.13		
	$TY_2 - TY_1$	0	0	0		3	0.45	0.87		
	$TY_3 - TY_2$	0	0	0		3	0.71	1.74		
	$TY_{51} - TY_3$	0	0	0		3	0.79	72.9		
AAHUs:					0				1.5	1.5

Table 66
IWR-Plan Analysis
Costs and Outputs for Cost Effective and Best Buy Plans

Plan (Alternative)	Total Annual Cost ($)	Forest Output (AAHUs)	Wetland Output (AAHUs)	Total Output (AAHUs)	Cost Effective
No Action Plan	0	0	0	0	Best Buy
A1B0C0	3,484	7.7	1.5	9.2	Best Buy
A2B0C0	6,485	7.7	1.5	9.2	No
A0B1C0	1,134	2.1	0	2.1	Yes
A0B2C0	2,385	2.1	0	2.1	No
A1B1C0	4,618	9.8	1.5	11.3	Yes
A2B1C0	7,619	9.8	1.5	11.3	No
A1B2C0	5,869	9.8	1.5	11.3	No
A2B2C0	8,870	9.8	1.5	11.3	No
A0B0C1	11,240	20.6	1.5	22.1	Yes
A0B0C2	19,744	20.6	1.5	22.1	No
A1B0C1	14,724	28.3	3	31.3	Best Buy
A2B0C1	17,725	28.3	3	31.3	No
A1B0C2	23,228	28.3	3	31.3	No
A2B0C2	26,229	28.3	3	31.3	No
A0B1C1	12,374	22.7	1.5	24.2	Yes
A0B2C1	13,625	22.7	1.5	24.2	No
A0B1C2	20,878	22.7	1.5	24.2	No
A0B2C2	22,129	22.7	1.5	24.2	No
A1B1C1	15,858	30.4	3	33.4	Best Buy
A2B1C1	18,859	30.4	3	33.4	No
A1B2C1	17,109	30.4	3	33.4	No
A2B2C1	20,110	30.4	3	33.4	No
A1B1C2	24,362	30.4	3	33.4	No
A2B1C2	27,363	30.4	3	33.4	No
A1B2C2	25,613	30.4	3	33.4	No
A2B2C2	28,614	30.4	3	33.4	No

KEY:
A1 = Site 1 – North of PA 9 (seedling and wetland measures)
A2 = Site 1 – North of PA 9 (sapling and wetland measures)
B1 = Site 2 – East of PA 9 (seedling measure only)
B2 = Site 2 – East of PA 9 (sapling measure only)
C1 = Site 3 – East of PA 8 (seedling and wetland measures)
C2 = Site 3 – East of PA 8 (sapling and wetland measures)

Table 67
Incremental Cost of Best Buy Plan Combinations
(Ordered By Output)

Plan (Alternative)	Total Output (AAHUs)	Cost ($1)	Average Cost ($1/AAHU)	Incremental Cost ($1)	Incremental Output (AAHUs)	Incremental Cost ($) Per Output
No Action Plan	0.00	0.00				
A1B0C0	9.20	3,484.00	378.69	3,484.00	9.20	378.69
A1B0C1	31.30	14,724.00	470.41	11,240.00	22.10	508.59
A1B1C1	33.40	15,858.00	474.79	1,134.00	2.10	540.00

Table 67 shows that Plan A1B0C0 (Site 1) is the most cost effective of all Best Buy plans presented. Tables 64 and 65 reveal that this plan contributes approximately 7.7 AAHUs to the forest habitat and generates about 1.5 AAHUs for newly created wetland habitat, at a total annual cost of $3,484 (see Table 66). The incremental cost per AAHU is $378.69 (see Table 67). The AAHU outputs provided adequately compensate for the losses to forest and wetland habitats resulting from project impacts. The projected first-cost of implementing this plan is approximately $161,000 based on the updated October 2011 price level.

10.20.4 Cost Effectiveness and Incremental Cost Analysis Summary

Based on the analysis that was conducted, it was concluded that establishing woodlands on Site 1 by planting mixed tree species consisting of about 150 seedling trees per acre would compensate for the woodland impacts of 7.41 AAHUs on 21 acres, by providing 7.7 AAHUs of woodlands on about 12 acres. In addition, establishing wetlands on Site 1 by creating a 3-acre pond planted with a variety of aquatic plant plugs on 5- to 6-foot centers would compensate for wetland impacts of 1.1 AAHUs on 39 acres, by providing 1.5 AAHUs for wetland habitat on about 3.0 acres. The first cost for implementing the mitigation plan at Site 1, based on the updated October 2011 price level, is $161,000 for planting seedling trees and creating wetlands. O&M for the 50-year period of analysis would consist of additional tallow tree clearing from the mitigation forest area, replanting seedling trees and aquatic vegetation to offset expected mortality, and implementation of mitigation monitoring and contingency plans. These O&M costs would amount to approximately $396,770 for the period of analysis.

10.21 MITIGATION MONITORING AND CONTINGENCY PLANS

10.21.1 Introduction

Monitoring of mitigation sites is a critical part of the mitigation process. The purpose of monitoring is to:

- obtain an objective assessment of project progress towards predetermined project goals and success criteria;

- identify and correct problems through an adaptive management approach; and
- ensure that USACE Galveston District and Port Freeport (non-Federal sponsor) meet their compensatory mitigation obligations.

Monitoring of the mitigation sites developed for this proposed project will be a cooperative process. According to ER 1105-2-100, Section C-3(e) (10), the non-Federal sponsor is primarily responsible for mitigation monitoring to determine the success of mitigation measures. While the non-Federal sponsor is responsible for implementing the monitoring plan, the Galveston District will lead initial monitoring efforts, in cooperation with the non-Federal sponsor and the resource agencies (USFWS and TPWD), to ensure successful establishment of the mitigation features (i.e., riparian tree planting and creation of a pond with aquatic vegetation). The Galveston District will review monitoring results and will make decisions regarding corrective actions.

The non-Federal sponsor (Port Freeport) has stated its intent to enter into an agreement with TPWD under terms of a “land conservation easement.” The conservation easement would protect and preserve all created mitigation features and would protect the entire 117-acre riparian forest, which would encompass the proposed mitigation seedling plantings. All mitigation lands would be managed and monitored as one continuous ecological unit and would be protected in perpetuity from future development. Under the terms of the conservation easement, TPWD would be responsible for conducting long-term monitoring, once mitigation features are successfully established, to ensure continued success of these features.

10.21.2 Success Criteria

Success criteria are used to objectively evaluate the progress of mitigation projects in achieving predetermined objectives and to determine whether corrective actions need to be implemented. Because habitat functions are difficult to measure directly, success criteria may be based on an assessment of the structural attributes of restored habitats. In this way, structural attributes serve as surrogate measures of habitat function. Once site conditions have met or surpassed the predetermined structural thresholds, it is assumed that the desired functions are either currently being provided or will be provided given time.

Separate success criteria have been established for riparian and aquatic pond vegetation plantings. For the riparian forest mitigation feature, success criteria would be based on tree seedling survival. For the aquatic pond plantings, success criteria would be based on area of aquatic plant cover.

10.21.3 Riparian Tree Plantings

10.21.3.1 Establishment Year

The initial contract for the riparian plantings would require the survival of 90 percent of seedling trees at the end of the first year after completion of planting. To ensure successful establishment, seedlings would be regularly watered, mulched, and fertilized during the first year. A program of pest/invasive plant control within the seedling planting areas would also be maintained for the establishment year. If the 90 percent targeted survival rate is not met, replacement seedlings would be planted to reach the original planting density of 150 trees per acre. Costs for this survival warranty would be included in the cost of the initial planting contract. Following the establishment year, a 15-year postestablishment monitoring plan would begin.

10.21.3.2 Postestablishment Monitoring

Success criteria for tree seedling survivability are:

- Annually for 5 years after the end of the establishment year, a minimum survival target of 80 percent of original planting density
- At 10 years after the end of the establishment year, a minimum survival target of 75 percent of original planting density
- At 15 years after the end of the establishment year, a minimum survival target of 70 percent of original planting density

Tree mortality for seedlings is expected to approach 30 to 40 percent over the 50-year period of analysis. Supplemental seedling planting to offset tree mortality would occur in years 1–5, 10, and 15 if monitoring indicates that the minimum survival targets for the respective years have not been met. See Section 10.22 for more information on the adaptive management plan.

Success criterion for invasive or exotic plants is:

- Annually for 15 years after the end of the establishment year, invasive or exotic plants cover a maximum of 5 percent of the total acreage planted with tree seedlings

Inasmuch as a known invasive (Chinese tallow) is already present in the mitigation area, it is assumed that monitoring will confirm the presence of invasive/exotic plants in excess of the target maximum in the early years of the monitoring program. Therefore, costs for an annual plant control program are included in the mitigation monitoring cost estimate. Control methods, determined in consultation with resource agencies, would be developed to address specific SOC.

10.21.3.2.1 Monitoring Methods, Timing, and Duration

The goal for the monitoring program for the riparian tree plantings is to determine the survival rate of the planted seedlings and document the presence/extent of invasive/exotic plant species. Monitoring for survivability would be conducted in years 1–5, 10, and 15 after the end of the establishment year. Monitoring for invasive/exotic species would be conducted annually after the establishment year for 15 years. Field data would be compared to success criteria to determine whether the project has met or exceeded predetermined criteria.

Seedling survival would be recorded by pedestrian survey and photo-documentation. Monitoring data sheets would also document other relevant information such as general site conditions, damage by herbivory or vandalism, and erosion. Photographic monitoring would be conducted: (1) prior to project implementation to document preexisting site conditions: (2) following project implementation: and (3) at the end of annual monitoring of the growing season. Key project areas would be photographed from fixed photo-points (i.e., same station, same angle) to provide a consistent basis for visually comparing seedling growth and development through time. The exact number and location of photo-monitoring stations would be determined in the field during project implementation.

The extent of invasive/exotic species coverage would be documented annually for 15 years after the end of the establishment year by pedestrian survey and photographic monitoring, using the methodology described for tree seedling monitoring above.

10.21.3.2.2 Project Closure

The riparian mitigation component could be certified as successful at the end of 15 years with a minimum tree seedling survival rate of 70 percent and maximum invasive/exotic plant cover of 5 percent of the total acreage planted with tree seedlings.

10.21.4 Aquatic Pond Vegetation

10.21.4.1 Establishment Year

The initial contract for the creation and planting of a wetland pond would require the survival of 60 percent of the planted aquatic vegetation clumps or plugs 1 year after pond creation. Viable herbaceous and grass plants shall be indicated by the evidence of one or more new live plant shoots arising from each separate plant plug or clump. Plugs/clumps would be watered as necessary, and invasive/exotic plants would be removed as needed during the establishment year. If the 60 percent targeted survival rate is not met, replacement plugs/clumps would be replanted to reach the original medium planting density. Corrective actions for pond size, depth, or slope, if needed, would be accomplished during the establishment year. Costs for corrective construction and the plant survivability warranty would be included in the cost of the initial construction and planting contracts. Following the establishment year, a 5-year postestablishment monitoring plan would begin.

10.21.4.1.1 Postestablishment Monitoring

Success criteria for aquatic plant survivability are:

- At 1 year after the end of the establishment year, a minimum of 30–35 percent aquatic vegetation cover over the pond’s total acreage.

- At 3 years after the end of the establishment year, a minimum of 65–70 percent aquatic vegetation cover over the pond's total acreage.
- At 5 years after the end of the establishment year, a minimum of 70–75 percent aquatic vegetation cover over the pond's total acreage.

Supplemental planting to offset aquatic plant mortality or failure to spread naturally would occur in years 1, 3, and 5 if monitoring indicates that the minimum percentage coverage targets for the respective years have not been met. See Section 10.22 for more information on the adaptive management plan.

Success criteria for invasive or exotic plants

- Annually for 5 years after the end of the establishment year, invasive or exotic plants cover a maximum of 5 percent of the total pond acreage.

Inasmuch as a known invasive (Chinese tallow) is already present in the mitigation area, it is assumed that monitoring will confirm the presence of invasive/exotic plants in excess of the target maximum in the early years of the monitoring program. Therefore, costs for an annual plant control program are included in the mitigation monitoring cost estimate. Control methods, determined in consultation with resource agencies, would be developed to address specific SOC.

10.21.4.1.2 Monitoring Methods, Timing, and Duration

The monitoring goal for evaluation of aquatic pond vegetation is to determine whether the percentage cover of aquatic vegetation is meeting the success criteria for target years. Monitoring would determine whether the aquatic vegetation is establishing itself along the pond perimeter and within the pond by natural colonization, or whether efforts to assist development of aquatic vegetation may be necessary in order to meet minimum percentage cover targets.

Evaluation of aquatic pond vegetation would entail visually assessing and documenting development of vegetation areas within and along the perimeter of the pond, along with the substrates that support aquatic vegetation establishment. Monitoring would include (1) determining area of cover of aquatic vegetation and invasive/exotic species, and (2) documenting overall site conditions through same-station, same-angle photo-monitoring. These monitoring tasks would be performed by pedestrian survey and photographic documentation. Key locations would be photographed from fixed photo-points (i.e., same station, same angle) to provide a consistent basis for visually comparing vegetation growth and development through time. The exact number and location of photo-monitoring stations would be determined in the field during project implementation.

Monitoring for percentage cover of desirable aquatic vegetation would be conducted at years 1, 3, and 5 after the end of the establishment year. Monitoring for invasive/exotic species would be conducted annually after the establishment year for 5 years. Field data would be compared to the success criteria to determine whether the project has met or exceeded predetermined criteria.

10.21.4.1.3 Project Closure

The aquatic pond mitigation component could be certified as successful at the end of 5 years with a minimum percentage aquatic plant cover of 70–75 percent and maximum invasive/exotic plant cover of 5 percent of the total pond acreage.

10.22 CORRECTIVE ACTIONS (ADAPTIVE MANAGEMENT)

Corrective actions are actions or measures undertaken to address expected plant mortality as well as unforeseen changes to the mitigation features resulting from natural or anthropogenic causes. Corrective actions will be implemented where necessary, in order to meet predetermined success criteria to ensure survival of the mitigation measures.

10.22.1 Riparian Tree Plantings

If monitoring indicates that the minimum tree seedling survival rates for the respective monitoring years have not been met, supplemental plantings would be conducted according to original planting specifications. However, the original species composition may be altered to favor those species exhibiting the highest survival rates based on monitoring data. A maximum of two curative replanting responses could be performed, using original planting specifications to achieve success criteria.

10.22.2 Aquatic Plantings

If monitoring indicates that the minimum percentage aquatic vegetation cover for the respective monitoring years has not been met, supplemental plantings would be conducted using original planting specifications. Replanted areas would be inspected within 60 days following replanting to determine whether those replanting efforts meet the threshold of a satisfactory stand. "Satisfactory stand" is defined as planting areas with at least a 50–60 percent survival rate within 60 calendar days following the planting effort. Viable herbaceous and grass plants shall be indicated by the evidence of one or more new live plant shoots arising from each separate plant plug or clump.

10.22.3 Adaptive Management Costs

Adaptive management costs are included in the O&M cost for the mitigation plan and described in the Operations and Maintenance Manual. Potential adaptive management costs for the 50-year period of analysis are contained in Table 68 below.

Table 68
Adaptive Management Costs

Task Description	Frequency	Cost ($)
Replant Trees (12 acres @ 50 trees/acre)	Twice (As Required)	31,680
Replant Aquatic Vegetation for Pond (3 acres using original planting specifications)	Twice (As Required)	7,920
	Total	39,600

10.22.4 Annual Monitoring Reports

Monitoring reports would be prepared by the non-Federal sponsor and submitted to the Galveston District annually during the 15-year and 5-year monitoring periods for the riparian trees and aquatic vegetation, respectively. Copies of this report would be provided to representatives of the consulting State and Federal agencies. Monitoring would continue until it has been demonstrated that the mitigation has met the ecological success criteria as documented by the District Engineer and determined by the Division Commander. It is anticipated that ecological success criteria for the riparian tree and aquatic tree planting would be met by Year 15 and Year 5, respectively, and that monitoring will cease when certification is achieved.

Monitoring reports would contain all monitoring data and photographs, and all annual results will be presented in cumulative fashion. Monitoring reports would be submitted to the Galveston District within 3 months of when the monitoring was conducted.

The first report would be submitted after initial mitigation construction has been completed (i.e., riparian tree planting and planting of aquatic vegetation). This report would document and detail the mitigation effort. Any variances from the work plan or standard practices described in the mitigation plan would be noted in this document. A summary of work activities and their respective start and completion dates would be included.

Monitoring reports would consist of introduction, methods, results, and discussion sections. The introduction would include a brief narrative description of existing conditions, a site location map, maps showing key sampling locations (i.e., transects, photo-stations, etc.), and a review of success criteria. The methods section of the report would detail the methodology used to assess project performance for the mitigation features. Results from monitoring riparian tree plantings and aquatic vegetation would be summarized in the results section in tables and/or as text. Monitoring data sheets would be included as an appendix. The results section would also include one set of labeled photographs taken at each of the fixed-point photo-monitoring stations.

The discussion section of monitoring reports for both the riparian and aquatic components would include an assessment of project success based on the monitoring results directly related to set success criteria. The need for any corrective actions (i.e., supplemental planting) would also be identified in this section. If necessary, a proposed schedule for implementing corrective actions would be included. The discussion section would also include a description of any problems observed within the project site including, but not limited to, excessive inundation, drought, invasion by undesirable plant species, herbivory damage, plant diseases, excessive erosion, and evidence of vandalism or inadvertent damage.

10.22.5 Final Close-Out Monitoring Report

A final "close-out" monitoring report would be submitted following certification that success criteria have been met for the riparian trees and aquatic vegetation mitigation areas. This report would include data and a description of the final monitoring evaluation. It would also provide a summary and analyses of annual monitoring results for the monitoring period for the entire mitigation site.

10.23 MITIGATION MONITORING AND REPORTING COSTS

Monitoring and reporting costs would be included in the O&M cost for the mitigation plan and described in the Operations and Maintenance Manual. Projected monitoring and reporting costs for the 50-year period of analysis are found in Table 69.

Table 69
Mitigation Monitoring and Reporting Costs

Task Description	Monitoring Interval	Cost ($)
Monitoring of Trees/Pond	Annual (Years 1–5, 10, 15)	44,330
Monitoring of Pond Aquatic Vegetation	(Years 1, 3, and 5)	27,280
Invasive Plant Control	Years 1, 2, 3, 4, and 5 (estimated)	66,000
Monitoring Report	Annual	82,500
	Total	220,110

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11.0 50-YEAR DREDGED MATERIAL MANAGEMENT PLAN EVALUATION AND SELECTION

11.1 DREDGED MATERIAL PLACEMENT PLAN

Deepening and widening Freeport Harbor to 55/50 feet by 600 feet, as well as the deepening and widening of the Stauffer Channel, will generate approximately 14.3 mcy of new work material and 176 mcy of additional maintenance material over the 50-year period of analysis. New work and maintenance dredged material from berthing areas outside of the Federal Channel (or any other non-Federal interest maintenance responsibilities) anticipated for placement in the placement sites for this project are insignificant when compared to the quantities associated with the Federal project and will not reduce the availability of the disposal facility for Federal navigation purposes; therefore, no additional non-Federal improvements to the placement sites are expected to be required to support containment of non-Federal interests dredged material. Approximately 680 acres of upland confined placement areas as well as one ocean dispersive site with unlimited capacity exist for development of a viable placement plan. Material will be placed in new upland sites and offshore sites.

To evaluate alternatives for placement of this material, existing placement areas were evaluated, along with a new area owned by the non-Federal sponsor. Each alternative plan mixed possible placement methods to maximize potential beneficial uses while minimizing costs.

Each of these plans had similar concepts. No alternative other than upland confined placement was considered for the Main and Stauffer channels due to the availability of existing sites near this channel reach with sufficient existing and future capacity for the required maintenance as well as concerns about contaminants in this highly industrialized area. The close proximity of available land owned by the non-Federal sponsor made upland confined placement the least-cost option.

11.2 50-YEAR CAPACITY AND DREDGED MATERIAL MANAGEMENT PLAN

11.2.1 Environmental Restrictions Pertaining to Upland and Offshore Dredge Material Placement

11.2.1.1 Upland PA Water Quality

The upland PA levee designs include freeboard allowances that provide needed settling time of soil particles within effluent discharge material at the PA, promote lower levels of turbidity in fluids exiting the drop-outlet structures, and support efforts at meeting the legal/allowable turbidity levels. Development of levee height requirements on this project was based on an allowance of 3 feet of freeboard above the bulked dredge fill height for each dredging event. Other factors may influence settling time including the discharge flow rate implemented by the dredging contractor. Specification language is added at the time contract plans and specifications are produced that provides additional restrictions on contractor dredging operations such that effluent concentrations at drop-outlet structure are within legal/allowable limits.

11.2.1.2 Ocean Dredged Material Disposal Site

ODMDS areas were modeled using MDFATE to analyze the effects of offshore placement to ensure conformance with fill-height restrictions on the bottom of the seafloor and other EPA criteria. The offshore dredge material quantities estimated for the Recommended Plan are shown in Table 70.

11.2.2 Dredge Materials and Potential for Beneficial Use

Results from bed sediment studies (from the *Desktop Sediment Study for Freeport Project* generated by ERDC and Hydrology and Hydraulics [H&H]), for bed sediment data collected between September 1987 through May 2000, indicate the following average percentages of bed sediments have been encountered in the channel:

1. Outer Bar – About 82 percent fine-grained sediments (silts and clays) and 18 percent sands
2. Jetty Channel – About 86 percent fine-grained sediments (silts and clays) and 14 percent sands
3. Freeport Harbor Channel – About 95 percent fine-grained sediments (silts and clays) and 5 percent sands

A review of new work materials from boring data starting at the Upper Turning Basin on out to sea indicate about 80 to 90 percent clays (of primarily stiff consistency with some traces of silts or clayey silts) and about 10 to 20 percent sands of various densities.

Based on groundwork done in the Widening Project study by Port Freeport, which included considering applicability and functionality of material types for particular beneficial use features, cost effectiveness, permanence of features, and other considerations explored by the widening project DMMP workgroup, the decision was made by the Project Delivery Team on the USACE's deepening and widening project to forgo pursuit of beneficial use features in the final selected dredge material management plan.

11.3 50-YEAR CAPACITY AND DREDGE MATERIAL PLACEMENT DESIGNATION

Table 70 displays the breakout of new work from the channel and anticipated distribution to the PA sites. Table 71 displays the 50-year levee elevations required for capacity and the anticipated cyclical maintenance dredging of the Main Channel and Stauffer Channel.

11.4 OCEAN DREDGE MATERIAL DISPOSAL SITES

Existing Maintenance and New Work ODMDSs are located within the project area at the coordinates below. These are dispersive sites consisting of approximately 1,291 and 2,236 acres, respectively, and were originally designated in the EPA FEIS for the Freeport Harbor 45-foot Project in January 1990. In August 2008, USACE gained EPA concurrence for placing maintenance and new work dredged material from the proposed project into these sites. Modeling was conducted for these sites, and it was determined that sufficient space exists for maintenance and new work material placement from both the non-Federal permit widening project and the proposed Federal project.

1) Maintenance ODMDS: The Maintenance ODMDS is located approximately 3 miles offshore and about 1,000 feet southwest of the centerline of the Outer Bar Channel. The site is rectangular in shape with corner coordinates located at:

   28°54′00″N, 95°15′49″W; 28°53′28″N, 95°15′16″W;

   28°52′00″N, 95°16′59″W; 28°52’32″N, 95°17′32″W

2) New Work ODMDS: The New Work ODMDS is located approximately 6 miles offshore. The site is bounded by the following coordinates:

   28°50′51″N, 95°13′54″W; 28°51′44″N, 95°14′49″W;

   28°50′15″N, 95°16′40″W; 28°49′22″N, 95°15′45″W

In this plan, all of the new work material from the Outer Bar Channel portion of the proposed Federal channel was evaluated for placement offshore.

Table 70
Freeport Harbor Channel Improvement Project – Summary of New Work Dredging

Freeport Harbor Deepening & Widening – Summary of New Work Dredging										
Alternative	**Channel Reaches**	**Channel Reach Stationing**		**Required Quantity (cy)**	**Overdepth Quantity (cy)**	**Total Quantity (cy)**	**Dredging Stationing & Placement Site Designation**			**Quantity Breakdown to Placement Sites (cy)**
		To	**From**				**To**	**From**	**Site**	
NED	Future Channel Extension	–470+00	–300+00	2,000,000	670,000	2,670,000	–470+00	–300+00	ODMD S 1	14,957,454
	Outer Bar Channel	–300+00	00+00	7,800,000	1,300,000	9,100,000	–300+00	00+00		
	Jetty Channel	00+00	71+52	2,900,000	287,000	3,187,000	00+00	71+52		
	Lower Turn Basin	71+52	78+52	280,000	38,000	318,000	71+52	78+52	PA 8	2,087,559
	Ch to Brazosport & New 1,200-foot Brazosport TB	78+52	115+00	2,200,000	116,000	2,316,000	78+52	102+00		
							102+00	115+00	PA 9	3,396,987
	Ch from Brazosport TB	115+00	132+66	513,000	34,000	547,000	115+00	132+66		
	Ch to Upper TB & Upper TB	132+66	184+20	380,000	110,000	490,000	132+66	184+20		
	Stauffer Channel, Lower Stauffer TB	184+20	222+00	1,340,000	45,000	1,113,000	184+20	222+00		
	Stauffer Channel, Upper Staffer & TB	222+00	260+00	390,000	37,000	427,000	222+00	260+00		
	Total			**17,803,000**	**2,639,000**	**20,442,000**				**20,442,000**
LPP	Future Channel Extension	–370+00	–300+00	500,000	295,000	795,000	–470+00	–300+00	ODMD S 1	9,733,297
	Outer Bar Channel	–300+00	00+00	4,990,000	1,300,000	6,290,000	–300+00	00+00		
	Jetty Channel	00+00	71+52	2,345,000	303,000	2,648,000	00+00	71+52		
	Lower Turn Basin	71+52	78+52	170,000	38,000	208,000	71+52	78+52	PA 8	1,853,144
	Ch to Brazosport & New 1,200-foot Brazosport TB	78+52	115+00	1,600,000	116,000	1,716,000	78+52	105+20		
							105+20	115+00	PA 9	2,765,559
	Ch from Brazosport TB	115+00	132+66	357,000	34,000	391,000	115+00	132+66		
	Ch to Upper TB & Upper TB	132+66	184+20	380,000	110,000	490,000	132+66	184+20		
	Stauffer Channel, Lower Stauffer TB	184+20	222+00	1,340,000	47,000	1,387,000	184+20	222+00		
	Stauffer Channel, Upper Staffer & TB	222+00	260+00	390,000	37,000	427,000	222+00	260+00		
	Total			**12,072,000**	**2,280,000**	**14,352,000**				**14,352,000**

Table 71
Freeport Harbor Channel Improvement Project – Summary of Maintenance Dredging & Placement Area Parameters

Freeport Harbor Deepening & Widening - Summary of Maintenance Dredging & Placement Area Parameters

Alternative	Channel Reaches	Channel Reach Stationing To	Channel Reach Stationing From	Annual Shoaling Rate From Channel Reaches (CY)	Dredging Stationing & Placement Site Designation To	Dredging Stationing & Placement Site Designation From	Site	Approximate Size of Placement Site (Ac)	Aprx. Existing Levee Elevation (ft in MLT)	1st Construction Lev. Elev. (ft in MLT)	Shaped NW Lev. Elev. (ft in MLT)	50-Year Levee Elev. (ft in MLT)	Annual Shoaling Rate to Placement Site (CY)	Years Per Cycle	Dredge Quantity Per Cycle (CY)	Total Number of Cycles	Total 50-Year Maintenance Dredging Quantity (cu yds)
NED	NED Extension	-450+00	-300+00	1,044,448	-450+00	-300+00	ODMS 1A	1,291	NA	NA	NA	NA	3,472,580	1	3,472,580	50	173,628,985
	Entrance Bar Channel	-300+00	00+00	2,088,897	-300+00	00+00											
	Jetty Channel	00+00	71+52	316,289	00+00	71+52											
	Lower Turning Basin	71+52	78+52	22,946	71+52	78+52											
	Ch to Brzpt & Brzpt TB	78+52	115+52	142,181	78+52	90+20	PA 1	320	29.0	31.5	31.5	33.5	44,883	3	134,649	16	2,154,384
					90+20	115+52	PA 8	168	NA[1]	20.0	32.5	32.5	119,183	3	357,550	16	5,720,805
	Ch to Upper TB	115+52	132+66	57,889	115+52	122+00											
					122+00	132+66	PA 9	254	NA[1]	20.0	32.5	32.5	177,700	3	533,101	16	8,529,620
	Ch to UP TB & UP TB	132+66	184+20	141,697	132+66	184+20											
	Lower Stauffer TB	184+20	222+00	4,826	184+20	222+00							9,826	12	117,912	4	471,648
	Upper Staffer TB	222+00	260+00	5,000	222+00	260+00											
	Total			**3,824,173**									**3,824,173**				**190,505,443**
LPP	NED Extension	-450+00	-300+00	873,159	-450+00	-300+00	ODMS 1A	1,291	NA	NA	NA	NA	3,188,339	1	3,188,339	50	159,416,960
	Entrance Bar Channel	-300+00	00+00	1,969,531	-300+00	00+00											
	Jetty Channel	00+00	71+52	324,554	00+00	71+52											
	Lower Turning Basin	71+52	78+52	21,095	71+52	78+52											
	Ch to Brzpt & Brzpt TB	78+52	115+52	132,400	78+52	89+10	PA 1	320	29.0	31.5	31.5	33.5	37,859	3	113,577	16	1,817,240
					89+10	115+52	PA 8	168	NA[1]	18.5	32.0	32.0	119,008	3	357,025	16	5,712,400
	Ch to Upper TB	115+52	132+66	53,220	115+52	123+40											
					123+40	132+66	PA 9	254	NA[1]	18.5	32.0	32.0	170,450	3	511,350	16	8,181,594
	Ch to UP TB & UP TB	132+66	184+20	141,697	132+66	184+20											
	Lower Stauffer TB	184+20	222+00	11,507	184+20	222+00							16,907	12	202,884	4	811,536
	Upper Staffer TB	222+00	260+00	5,400	222+00	260+00											
	Total			**3,532,564**									**3,532,564**				**175,939,729**

Notes:

1) For new PA 8 & 9, an existing ground elevation level of 5 feet MLT is assumed at start of project. Detailed elevation surveys will be performed during subsequent design phases of the project. The initial assumed elevation is anticipated to be on the upper end of the range of potential existing elevations at these new sites.

2) For materials designated to go offshore, approximately 1 million cubic yards per year falls within footprint of separate widening permit action being pursued by Port of Freeport.

11.5 UPLAND CONFINED PLACEMENT PLAN

There are a number of existing upland confined sites at Freeport. The Freeport Harbor Project currently uses PA 1, a 330-acre site. Two other PAs, PA 2 and PA 3 (see Figure 2), are designated for use by GIWW dredging. An estimated additional 418 acres were needed for the proposed project.

In this plan, all of the material from the Main Channel (Lower Turning Basin to the Upper Turning Basin) and the Stauffer Channel is to be placed in upland confined sites, PAs 8 and 9.

11.5.1 Existing Placement Area 1

Existing PA 1 is located in Freeport about 0.5 mile south of SH 36 and about 1,000 feet east of the Brazos River Diversion Channel. It is estimated at approximately 320 acres in size, with about 20,310 linear feet of exterior perimeter levee, an assumed average interior elevation of 26 feet MLT, and assumed average levee elevation of 29 feet MLT. Assumed average elevations are based on anticipated elevations following the completion of O&M contract awarded in 2009.

11.5.2 New Placement Area 8

New PA 8 is located in Freeport just north of SH 36 and approximately 1,600 feet west of the Brazos River Diversion Channel. PA 8 is about 168 acres, with a perimeter length of about 11,480 linear feet, and assumed existing ground elevation around 5 feet MLT. As a currently undeveloped site, and given the proximity to the coast, an initial assumed elevation of 5 feet MLT is anticipated to be on the upper end of the range of potential existing elevations at the site.

11.5.3 New Placement Area 9

New PA 9 is located in Freeport just north of Old SH 36, and approximately 300 feet west of the Brazos River Diversion Channel. PA 9 is about 250 acres, with a perimeter length of about 14,000 linear feet, and assumed existing ground elevation around 5 feet MLT. With the proximity to the coast and fact that the land is undeveloped, this initial assumed elevation is anticipated to be on the upper end of the range of potential existing elevations at the site.

11.5.4 Verification of Placement Area Elevation Data

The above approximate elevations have been used by Geotechnical Engineering in the preliminary engineering calculations used to produce the cost estimates. During PED or subsequent design phases, the latest available survey data will be utilized and the engineering quantity estimates will be updated accordingly.

11.6 BENEFICIAL USE PLACEMENT PLAN

One of the main interests in the consideration of a 50-year DMMP is to maximize the use of suitable-quality dredged material for beneficial purposes. In coordination with the resource agencies and the public, beneficial uses were investigated to determine the feasibility of implementation. Because of the unsuitability of the dredged material, the presence of sensitive resources at sites, and the prohibitive cost of placement at one site, no beneficial use plan was developed.

11.7 DREDGED MATERIAL MANAGEMENT PLAN

11.7.1 Outer Bar Channel – Stations –370+00 to 71+52.58

All material, both new work and maintenance, will be placed in offshore sites. All of these sites are unconfined, and no structural control will be utilized to contain material. Deepening and widening of the channel will generate approximately 12.7 mcy of new work material and 3.4 mcy of maintenance material annually.

11.7.2 Main Channel – Stations 71+52.58 to 184+20

Deepening and widening of this portion of the channel will generate approximately 2.8 mcy of new work material and 364,000 cy of maintenance material annually. New work material is largely made up of sandy clay while the maintenance material is expected to be composed of silt or sandy silt, which will be placed in confined upland PAs.

11.7.3 Stauffer Channel – Stations 184+20 to 256+00

Deepening and widening of Stauffer Channel will generate approximately 1.8 mcy of new work material and 187,000 cy of maintenance material annually. New work material generated from deepening and widening of the Stauffer Channel will be placed in new PA 9. Due to the large clay component of the new work material, it will be used in the future to elevate the levees of the PA to contain future maintenance material.

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12.0 PLAN SELECTION, RECOMMENDED PLAN, AND PLAN IMPLEMENTATION

12.1 OVERVIEW

The previous chapters described the analyses conducted during the planning study process to identify the NED Plan and the LPP with the ultimate goal of identifying the Recommended Plan. The plan selected will be recommended for implementation to the U.S. Congress. The Recommended Plan addresses the problems and opportunities identified at the beginning of the study and satisfies the planning objectives of increasing navigation efficiency and reliability along the Freeport Harbor Channel while maintaining or enhancing terrestrial, cultural, estuarine, and coastal resources within the project area.

As described in Section 8.2, all elevations referred to in this report, unless specifically noted otherwise, are based on Galveston District's local MLT datum. Army regulations and HQ guidance on tidal datum, provided in ETL 1110-2-349 *REQUIREMENTS AND PROCEDURES FOR REFERENCING COASTAL NAVIGATION PROJECTS TO MEAN LOWER LOW WATER DATUM*, dated April 1, 1993, and EM 1110-2-1003, April 1, 2002, stress the necessity of converting local datum, such as MLT to MLLW. EM 1110-2-1003 further states that MLLW should be tied to the NAVD 88. The Galveston District has an established survey control network along the Freeport Harbor Channel. To comply with the above-referenced guidance on referencing tidal datums using MLLW, the Galveston District took vertical survey measurements at tide gages and benchmarks to estimate the relative difference between MLT and MLLW datums along the Freeport Channel. The objective was to maintain an effective water depth of 55 feet while correctly referencing resulting water surface level in MLLW.

At Freeport Channel, datum values for MLLW are +1 foot above MLT. However, this does not result in increased water depth, as the additional +1 foot of nominal depth is actually +1 foot above the normal surface water level. Therefore, the actual water depths are equivalent between a 55-foot MLT channel template and a 56-foot MLLW channel template. As the study and its documentation was completed using MLT, references to MLT have been maintained throughout this document, though numbers are also referenced in MLLW depths at some locations in the report. These references are in parentheses, and the datum is referenced at each reference point. The Recommended Plan, described below, is the LPP, the plan preferred by the non-Federal sponsor. The current discount rate of 4.0 percent was used, and the period of analysis is 50 years.

12.2 RISK AND UNCERTAINTY

Risk and uncertainty is an important part of the USACE planning process and feasibility analyses. The "Economic and Environmental Principles for Water and Related Land Resources Implementation Studies," established pursuant to WRDA 65 (PL 89-80), as amended (42 United

States Code [USC] 1962, a-2 and d-1), requires that areas of risk and uncertainty be identified and clearly described so that public investment decisions can be made by the degree of reliability of estimated costs, benefits, and effectiveness of alternative plans. This approach captures and quantifies the extent of risk and uncertainty in the various planning and design components of a project. The total effect of risk and uncertainty on the project’s design and viability can be examined and conscious decisions made reflecting an explicit trade-off between risks and costs.

More recently, risk-informed decision-making has been emphasized as one of the four major themes in the USACE Actions for Change. This policy, developed from analyses done by the Interagency Performance Evaluation Taskforce in the aftermath of Hurricane Katrina, pointed to the need for organizational changes to transform USACE priorities, processes, and planning in an effort to improve public safety and USACE infrastructure. USACE has committed to developing and employing risk- and reliability-based approaches that evaluate the consequences of design, construction, and management decisions, especially as they affect risks to human health and safety.

Risk and uncertainty arise from measurement errors and the underlying variability of complex natural, social, and economic situations. Plans may be subject to measurement errors if the data are imperfect or the analytical tools are crude. Some future demographic, economic, or navigational uses are essentially unpredictable because they are subject to random influences. However, in some cases, the randomness can be approximated by developing a probability distribution using a historical database that is applicable to the future. If there is no such historical data base, the probability distribution of random future events can be described subjectively, based on best-available insight and judgment (ER 1105-2-100, E-4.a(3)). The latter case could also be applied to situations in which there is uncertainty as to whether historical conditions can be reliably applied to the future. Such is likely the case with environmental parameters affected by global warming, such as sea level rise. None of the historical databases in use today can reliably be used to predict future conditions in which the rates of change are clearly diverging from historical precedents (Intergovernmental Panel on Climate Change [IPCC], 2007).

A variety of specific technical terms and concepts that are employed in risk and uncertainty analysis are described below:

- “Risk” is the probability that a hazardous outcome will occur as a consequence of uncertainty. It is “conventionally defined as those (situations) in which the potential outcome can be described in reasonably well known probability distribution” (ER 1105-2-100, E-4.a.(1)). These distributions are generally based upon well-established, empirical data (historical or experimental). The best-known examples of this concept are applied in flood risk management projects.
- “Uncertainty” is a measure of imprecision of knowledge of parameters and functions used to describe the hydraulic, geotechnical, ecological, and economic aspects of a

project. "In situations of uncertainty, potential outcomes cannot be described in objectively known probability distributions. . . . Because there are no known probability distributions to describe uncertain outcomes, uncertainty is substantially more difficult to analyze than risk" (ER 1105-2-100, E-4.a.(2)).

- "Risk-based analysis" is defined as "an approach to evaluation and decision-making that explicitly . . . incorporates consideration of risk and uncertainty to compare plans in terms of likelihood and variability of physical performance, economic success and residual risk" (ER 1105-2-100, 2-4.g). Analytical evaluation is sometimes restricted by a lack of data and understanding of biological and physical processes, effectively limiting risk considerations to more-subjective comparisons.
- "Sensitivity analysis" is a technique that varies assumptions of economic, demographic, environmental, and other factors and examines the effects of varying these assumptions on outcomes of benefits and costs (ER 1105-2-100, E-4.b.(1)(b)(6)).
- "Residual risk" is a concept best understood in relation to flood risk management studies. However, for navigation studies, one type of residual risk might be risk that benefits are foregone to those situations where LPPs are selected over the NED, such as in this study.

12.2.1 Uncertainty in Technical Evaluations

Forecasting future scenarios is an important part of the USACE planning process. In order to evaluate the risks and benefits of alternatives over the period of analysis, a forecast is created based on historical and existing information, as well as quantitative and qualitative assumptions about what may happen within the study area in the future. One method is to identify the "most likely" future or the best guess about what may happen based on observed variables and assumptions of both natural and human behavior. Another method is to conduct scenario planning, where multiple future scenarios are created in order to evaluate what would happen if observed variables or assumptions do not happen as projected. Scenario planning attempts to answer the "what if" questions that arise when making forecasting assumptions and predictions. For the Freeport Harbor Feasibility, the "most likely future" method was chosen due to project scope.

12.2.1.1 Engineering Data and Models

After the identification of the most likely FWOP scenario for the Freeport Harbor Channel, the next step was the evaluation of alternatives using H&H models and economic models. H&H models included RMA-2 and TABS MD numerical hydrodynamic models, ADCIRC and GENESIS.

The primary objective of the hydrodynamic model studies was to provide accurate and representative current velocity fields for use in the ship simulator for the navigation study. The secondary objective was the development of a tool that was used to evaluate the general impacts of the design alternative improvements on circulation in the harbor. Field data were collected for the hydrodynamic models. The study developed a numerical hydrodynamic model using the TABS-MD modeling system with the Surface-water Modeling System as the graphical user interface. The computational mesh was designed to capture all of the major details of the existing and proposed design alternatives. This study takes into account the proposed LNG terminal.

The numerical model was verified to the field data. The verification was performed by comparing the model to observed water surface elevation fluctuations and to current velocity variations. After the model was verified, the computation mesh was revised to reflect the two design alternatives. The model was then run for the verification period with each of the two alternatives. The simulations were examined for extreme maximum flood and ebb currents, and those conditions were provided to the ship simulator for incorporation into the navigation study. The results showed that the numerical model was reasonably verified against field observations to make it a valuable tool in the evaluation of circulation effects associated with the design alternatives.

A cursory-level numerical study was conducted to determine whether the planned improvements to the channel will make Freeport Harbor and adjacent, low-lying areas more susceptible to inundation due to hurricane-induced storm surge. The improvements modeled was the 60-x-600-foot channel with a 1,350-foot Brazosport Turning Basin, which removes a portion of the southeastern peninsula (North Wave Barrier) that separates the GIWW from the harbor proper, and the proposed LNG improvements. The existing ADCIRC model that was developed for a coastal erosion study was adapted to depict the planned harbor configuration. Hurricanes selected for simulation were based on the September 1941 hurricane and Hurricane Fern, which impacted the Texas coast in September 1971. These hurricanes were selected because both came within close proximity to the study area and produced relatively high surges. Stronger hurricanes, such as the 1900 Hurricane, were omitted from the analysis because they would have generated significantly greater overland flooding; this, in turn, hampers determining whether the planned improvements make the Freeport Harbor more susceptible to storm surge. The model found little change in peak water-surface elevations within the harbor resulting from the planned improvements. Estimated increases were about 0.16 foot. Consequently, the planned harbor improvements do not appear to make the harbor and adjacent low-lying areas more susceptible to storm surge from less-intense hurricanes.

A shoreline impact study was conducted to assess the wave-induced impacts of the proposed deepening of the Freeport Channel in the Gulf of Mexico on the open-coastal shorelines adjacent to the project area. This study used the numerical model GENESIS to compute sediment transport rates and shoreline change rates for each of the four proposed channels. Comparing the GENESIS output for the existing condition with the proposed channels output revealed the effects of the bathymetry changes on the wave-induced longshore transport and the shoreline change rate. Breaker wave heights and angle inputs to GENESIS were obtained from the numerical wave propagation and refraction model, STWAVE. STWAVE modeled the refraction over the different bathymetry grids corresponding to the existing and proposed channels. Texas shoreline change rates have been calculated by the Bureau of Economic Geology. Their change rates were obtained using a regression analysis of the available shorelines. Their analysis shows that in the vicinity of Freeport Harbor, the shoreline is eroding at a rate of 9 to 10 ft/yr. Five to six miles northeast of the harbor, the shoreline is shown to be stable, and farther northeast it again becomes erosional. Between the Brazos and the San Bernard River mouths, the shoreline is very dynamic, with strong erosional and accretional regions. The conclusion from this analysis is that if any of the proposed deepening alternatives for the Freeport Outer Bar Channel are constructed, the wave-induced sediment transport impacts on the adjacent shorelines will be so slight as to not be noticeable and will be dwarfed by the interannual variability in shoreline position.

12.2.1.2 Economic Analysis

Economic analysis was based on the existing traffic base and vessel utilization. Traffic forecasts were projected for the "most likely" scenario. Project alternatives were evaluated and benefit calculations made. Transportation savings benefits were established and benefit-cost analysis was conducted.

12.3 SENSITIVITY OF PROJECT ALTERNATIVES TO RELATIVE SEA LEVEL RISE

Sea level rise can affect coastal communities and habitats in a variety of different ways, including submerging low-lying lands, eroding beaches, converting wetlands to open water, intensifying coastal flooding, and increasing the salinity of estuaries and freshwater aquifers. It is caused by a number of natural and human-induced factors and can vary by region. Some impacts of sea level rise can already be observed along the U.S. coast. The primary causes of global sea level rise are the expansion of ocean water due to warming and the melting of glaciers and ice sheets. Locally, sea level rise is also influenced by changes to the geology of coastal land.

RSLR consists of two components: global (eustatic) sea level rise and local subsidence. The uncertainty inherent in the rates of eustatic sea level rise is evident in the variability of the different modeled rates given for the National Research Council (NRC, 1987) projections and the IPCC (2007). A similar degree of uncertainty exists with the rate of local subsidence.

Recent USACE guidance (Engineering Circular [EC] 1165-2-211, July 2009) provides direction for incorporating the direct and indirect physical effects of projected future sea level change in managing, planning, engineering, designing, constructing, operating, and maintaining USACE projects and systems of projects. Recent climate research by the IPCC predicts continued or accelerated global warming for the twenty-first century and possibly beyond, which will cause a continued or accelerated rise in global mean sea level. Impacts to coastal and estuarine zones caused by sea level change must be considered in all phases of Civil Works programs.

In order to meet the requirements of EC 1165-2-211, the sensitivity of project alternatives to potential FWOP changes in sea level must be evaluated. The range of RSLR was determined using both tide gage and basal peat data for the local subsidence component of RSLR. Tide gage data reflect the effects of recent historical subsidence.

The recent historic rate of local RSLR extracted from the NOAA tide gage at Freeport, Texas, is 0.0143 ft/yr, for the 52-year period between 1954 and 2006 (NOAA, 2006). Data originated by NRC (1987) and modified by IPCC (2007) assume a historic eustatic rate equal to the globally averaged rate, which is 1.7 mm/year (0.0056 ft/yr). Subtracting the historic eustatic rate from the local RSLR rate yields an estimated observed subsidence rate of 2.65 mm/yr (0.0087 ft/yr) for the Freeport area.

To date, however, there is no scientific consensus concerning the projection of future subsidence rates in the Texas and Louisiana coastal region. The relative influence of historic anthropogenic activities in this area (e.g., oil and gas withdrawal) is difficult to quantify. If these activities contributed significantly to recent observations of subsidence, then significant reductions or cessation of these activities may result in rapid deceleration of subsidence rates, returning them to long-term average rates.

Several studies of basal peat layers have been conducted in the Texas and Louisiana coastal region to determine estimates of the long-term average rates of subsidence. These rates are generally on the order to 0.5 mm/yr (0.0016 ft/yr) (Törnqvist et al., 2006). This rate is significantly lower than the observed tide gage rates. Therefore, if historic anthropogenic activities are largely responsible for the accelerated rates observed in the tide records, then we would expect the projected rates to decelerate rapidly over the next several decades.

Deriving RSLR estimates using both basal peat and tide gage data, possible RSLR rates were estimated for a 50-year period of analysis (the period from 2015 to 2065) to range from 0.36 to 2.40 feet. Possible low (historic), intermediate, and high RSLR rates are given for subsidence values that correspond to both the observed tidal gage values (rapid subsidence), and the observed basal peat values (moderate subsidence) and are as follows:

- 0.71 foot, Low (216 mm/yr), based on tide gage subsidence rates
- 0.36 foot, Low (109.7 mm/yr), based on basal peat subsidence rates
- 1.11 feet, Intermediate (338 mm/yr), based on tide gage subsidence rates
- 0.76 foot, Intermediate (232 mm/year), based on basal peat subsidence rates
- 2.40 feet, High (732 mm/yr), based on tide gage subsidence rates

- 2.04 feet, High (662 mm/yr), based on basal peat subsidence rates

RSLR rates for the project area are discussed in greater detail in Appendix L of the FEIS.

The most apparent potential for RSLR impacts in the Freeport Harbor project area includes impacts on wetlands and other sensitive low-lying areas due to higher water levels, impacts on vessel navigation due to changes in current velocities in the area, and impacts on surge levels. These potential impacts are examined in Section 4, Environmental Consequences, of the FEIS.

12.3.1 Projected Relative Sea Level Rise Impacts for the Project Area

The potential for RSLR impacts in the Freeport Harbor project area includes impacts on wetlands and other sensitive low-lying areas due to higher water levels, impacts on vessel traffic due to changes in current velocities in the area, and impacts on surge levels.

In general, the functioning of the navigation features associated with all alternatives (channel depths of 55 through 60 feet, turning basins, PAs, and ODMDSs) would be insignificantly affected by the full range of potential sea level change. Upland confined PAs and mitigation features are located at sufficiently high elevations to withstand the full range of potential RSLR. The following discussion describes possible ways that RSLR might affect the project alternatives.

Numerical modeling performed for the proposed project shows that implementation of the NED or LPP, Plan 4 and Plan 5, would result in changes in the velocities in the harbor, the tides in the harbor, and the surge values. The depth-averaged velocities in the harbor show, for both plans, a decrease in peak ebb and flood velocities of from 0.0 to 0.18 ft/sec (5.4 centimeters per second [cm/sec]), the decrease becoming less moving upstream into the harbor. The two plans produce tidal results that are essentially identical. Tidal differences include advancement of the flood and ebb tides by approximately 30 minutes in this diurnal system, and an increase in the mean tide range of about 0.3 percent, or 0.01 foot (0.2 centimeter [cm]). The surge values for the plans are about 0.16 foot (5 cm) higher with the plans than without them.

These differences in tidal velocities, tidal timing and tide range, and surge are the result of physical changes to the system in the plans. The plan changes are of two types. One change involves an increase in the area of the harbor through the removal of parts of the southwest peninsula separating the harbor from the GIWW; the other change is the deepening and widening of the channels.

Both types of changes tend to increase the coupling of the harbor to the Gulf. The excavation of portions of the southwest peninsula will increase the tidal prism of the harbor by about 0.05 percent. This increased tidal prism results in more water moving into and out of the system during each tidal cycle. Since more water is entering and leaving the system during each tidal cycle, peak velocities are expected to increase as a result. Deepening and widening of the Jetty Channel and the inner basin also result in a stronger coupling between the Gulf and the harbor. This deepening and widening of the harbor results in increases in the volume of the harbor of from 5.8 percent (Plan 5) to 6.4 percent (Plan 4). The increased cross-sectional area for the water to flow into the system will result in decreased peak velocities. Detailed numerical modeling shows that the net effect of these competing processes is to lower the peak velocities, up to 0.18 ft/sec (5.4 cm/sec), in the harbor, as one would expect from the relative size of the effects. With the projected RSLR, the system is, in effect, deepened from 0.36 foot (11.0 cm) to 2.4 feet (73.2 cm), depending on the sea level rise and subsidence scenario. This additional “deepening” will result in further, though slight, decreases in peak velocities by further increasing the cross section of the channel.

The increased coupling also affects the tide. The advancement of the timing of the tide means that, with the deeper and wider channel, the tide can move into and out of the harbor more easily, and thus, the timing of the tide will change. Deepening of this type generally also causes an increase in the tide range inside a waterway; the range of the driving Gulf tide is diminished less as it experiences relatively less friction, due to the deeper water, as it travels up into the system. In this case, however, the system in its existing condition is already well coupled to the Gulf, as evidenced by the similarity of the tides in the jetties to those in the harbor. Given the lack of resonant behavior in the short channel (about 3 miles [5 kilometers]) from jetties to the end of the deepened portion of the channel), only small increases in the tide range, predicted to be about 0.3 percent, or 0.01 foot (0.2 cm) for a mean tide of 1.64 feet (50 cm), can be expected with further deepening and widening. Again, with the projected RSLR for this system, no additional increase in tidal range is expected since the incremental change, due to RSLR, decreases the relative differences between the Base and Plan conditions.

The increased coupling due to the project also affects the surge, increasing the surge levels by about 0.16 foot (5 cm) locally. The percent differences of water level in the system between the with-project and without-project cases for RSLR of 0.36 foot (11.0 cm) to 2.4 feet (73.2 cm) will be smaller than without RSLR. The differences in surge height are thus expected to be less as well. Additionally, the effects of increased surge due to the project are local, and given the general inundation of the greater Freeport area during a significant surge, the additional water elevation due to the project, with or without RSLR, is expected to be small.

Given the above discussion, impacts on wetlands in the Freeport Harbor are thus expected to be negligible for two reasons. First, there are no wetlands in the footprint of the channel system. Second, changes in tidal range are expected to be small and difficult to measure, residing in the millimeter range. Since Freeport Harbor is a highly developed industrial area with no wetlands or other marshes, water level changes due to RSLR will have an effect on the harbor similar to that of a deepening. As seen in the modeling and an examination of the tide data, the harbor is already, at current depths and cross sections, closely coupled to the Gulf so that any further increases in depth will result in very small increases in tide range. Thus, RSLR is expected to result in an insignificant difference between the existing channel conditions and the plans.

Impacts on navigation are also expected to be negligible, with currents likely decreasing, with RSLR, even further from the decreases expected with the project. RSLR, serving in this case as essentially a deepening, means that an even larger effective cross-sectional area will be available for the flooding and ebbing tides, and that the peak velocities will decrease further. Hence, RSLR is expected to cause an insignificant difference between the existing channel and the plans.

Finally, impact differences on the surge levels due to the project, with and without RSLR, are expected to be very small and local.

12.4 DESCRIPTION OF RECOMMENDED PLAN

Based on the economic, engineering, and environmental factors considered, the Recommended Plan (LPP) includes deepening of the Outer Bar Channel from the jetties into the Gulf of Mexico to –57 feet MLT (–58 feet MLLW); deepening from the end of the jetties in the Gulf of Mexico to the Lower Turning Basin to –55 feet MLT (–56 feet MLLW); deepening the Main Channel from the Lower Turning Basin to Sta. 132+66 (ConocoPhillips dock area, above 1,200-foot Brazosport Turning Basin) to –55 feet MLT (–56 feet MLLW); deepening of Freeport Harbor from Sta. 132+66 through the Upper Turning Basin to –50 feet MLT (–51 feet MLLW); deepening and widening the lower 3,700 feet of the Stauffer Channel at a depth of –50 feet MLT (–51 feet MLLW) and 300 feet wide; and dredging the remainder of the Stauffer Channel to a depth of –25 feet MLT (–26 feet MLLW), in lieu of restoring it to its previously authorized dimensions of 30 feet by 200 feet. Depths shown exclude advance maintenance and allowable over-depth. It is estimated that the approximately 14.3 mcy of new work material (including advance maintenance and allowable over-depth) would require eight separate dredging contracts to complete. The work is estimated to begin in 2015 and be complete by 2021. Dredged material management will be performed according to the DMMP. The Recommended Plan meets the requirements for a categorical exemption in accordance with ER 1105-2-100, Section 3-2.b.10.

12.5 GENERAL NAVIGATION FEATURES OF THE RECOMMENDED PLAN

Dredging of the Freeport Harbor Channel will include 2 feet of advanced maintenance below designated depths to ensure safe vessel passage. In addition, the Outer Bar Channel will include an additional 2 feet of dredging to account for the high wave environment offshore, outside the jetties.

12.5.1 Outer Bar/Jetty Channel

The Outer Bar/Jetty Channel is defined as that portion of Freeport Harbor extending from Station –370+00 in the Gulf of Mexico to Station 71+52 in the Lower Turning Basin. The Jetty Channel is 600 feet wide and protected on two sides by jetties. The land-locked portion of the Outer Bar/Jetty Channel would be deepened to –57 feet MLT (–58 feet MLLW). This would be modified in the portion of the channel that enters the open waters of the Gulf. This segment will be dredged to a –59-foot MLT (–60-foot MLLW) depth. The existing channel will be extended approximately 5,000 feet into the Gulf in order to reach the –59-foot MLT (–60-foot MLLW) contour. No modifications to the existing Freeport Harbor jetties are required by the proposed project. The Outer Bar/Jetty Channel will be constructed by hopper dredge beginning at the Lower Turning Basin and extending into the Gulf of Mexico to the –59-foot MLT (–60-foot MLLW) contour at the same bearing as the existing channel. New channel markers will be required to mark the new channel.

12.5.2 Main Channel

The Main Channel portion of Freeport Harbor extends from Station 71+52 in the Lower Turning Basin to the Upper Turning Basin. This segment will be deepened from an authorized depth of –45 feet to –55 feet MLT (–46 feet to –56 feet MLLW). From Station 132+66 to Station 184+20 at the Upper Turning Basin, the channel will be deepened to –50 feet MLT (–51 feet MLLW). Based on ERDC’s Ship Simulation Report, the recommended width for this portion of the channel is 400 feet. The Main Channel will be constructed by hydraulic pipeline dredge, with the dredged material going to new PAs 8 and 9. The Lower Turning Basin will maintain its existing 750-foot diameter and be deepened to –55 feet MLT (–56 feet MLLW). The Brazosport Turning Basin will be enlarged from its existing 1,000-foot diameter to a new 1,200-foot diameter. The Upper Turning Bain will maintain its existing 1,200-foot diameter and be deepened to –50 feet MLT (–51 feet MLLW).

12.5.3 Stauffer Channel

The Stauffer Channel will be deepened to –50 feet MLT (–51 feet MLLW) and widened to 300 feet for approximately 3,700 feet beyond its confluence with the Upper Turning Basin. The remaining channel will be deepened to a depth of –25 feet MLT (–26 feet MLLW) and 200-foot width to the Stauffer Turning Basin.

Because of the relationship between the deepening and widening of the Stauffer Channel of the existing Federal project and the proposed terminal, Port Freeport must initiate construction of the terminal facilities prior to, or concurrent with, construction of the Stauffer Channel improvements. Port Freeport will be responsible for obtaining the necessary permits required for the container terminal under Section 404 of the CWA, Section 10 of the RHA, and/or any other applicable jurisdictions as appropriate utilizing the procedures described by NEPA.

Table 72 displays the Recommended Plan dimensions. A breakdown of the channel reaches and what PA is designated is shown in Tables 70 and 71.

Table 72
Proposed Freeport Channel Dimensions for Recommended Plan

Channel Section	Required Depth MLT[1] (MLLW)	Width (feet)	New Work Quantity (cy)[2]
Future Channel Extension (Sta –300+00 to Stat –370+00)	59(60)	600	795,000
Outer Bar Channel (Sta 0+00 to Sta –300+00)	59(60)	600	8,290,000
Jetty Channel (Sta 0+00 to Sta 71+52.58	57(58)	600	3,648,000
Lower Turning Basin (Sta 71+52 to Sta 78+52	57(58)	existing	208,000
Channel to Brazosport and New 1,200-foot Turning Basin (Sta 78+52 to Sta 115+00)	57(58)	existing	2,916,000
Channel to Upper Turning Basin (Sta 115+00 to Sta 132+66)	57(58)	existing	391,000
Channel to Upper Turning Basin and Turning Basin (Sta 132+66 to Sta 184+20	52(53)	existing	490,000
Stauffer Channel – Lower Reach (Sta 184+20 to Sta 222+00)	52(53)	300	1,387,000
Stauffer Channel – Upper Reach (Sta 222+00 to Sta 260+00)	27(28)	200	427,000

[1] Includes Advance Maintenance (2 feet)
[2] Includes Allowable Over-depth

12.5.4 Lands, Easements, and Rights-of-Way

Port Freeport is required to furnish the lands, easements, rights-of-way, and relocations (LERRs) for the proposed cost-shared project. The real estate requirements must support construction as well as O&M of the project after completion. Specific details of the real estate requirements can be found in the Real Estate Plan, Appendix C of this document.

12.5.5 Facility Removals/Deep-Draft Utility Relocations

The USACE currently requires pipelines located below deep-draft navigation channels be buried 20 feet below the authorized project depth of the channel (Southwest-Galveston District Operations Manual 1145-2-15). This requirement was developed taking into consideration several factors, including geotechnical, hydraulic, navigation, maintenance dredging, and pipeline placement method considerations. Exceptions to this requirement can be granted on a case-by-case basis.

During the feasibility phase, one pipeline was identified for further consideration. However, surveys were conducted on the pipeline and it was found to have adequate coverage for the project. Therefore, no removals or relocations are required.

12.5.6 Regional Sediment Management

Section 2037 of WRDA 07 amended Section 204 of WRDA 92 dealing with regional sediment management. Section 204 states that a regional sediment management plan shall be developed by the Secretary of the Army for sediment obtained through the construction, operation, or maintenance of an authorized Federal water resources project. The purposes of using sediment for the construction, repair, modification, or rehabilitation of Federal water resource projects are to reduce storm damage to property; to protect, restore, and create aquatic and ecologically related habitats, including wetlands; and to transport and place suitable sediment.

During the non-Federal sponsor’s Section 204(f) Assumption of Maintenance study, beneficial use of the dredged material was investigated. The study, though not a part of the Federal feasibility study, concluded that use of material for any use in marshland or wetland restoration was not beneficial or cost effective. However, it was determined that there was a sand lens in the area to be widened that could be harvested for placement on the beach at Quintana. The non-Federal sponsor widening project is to place an estimated 300,000 cy of material on the Quintana beach area.

During the feasibility study, no suitable material could be found for beneficial use. Therefore, no regional sediment management plan was developed.

12.6 PLAN IMPLEMENTATION

12.6.1 Division of Plan Responsibilities and Cost-Sharing Requirements

The non-Federal cost-sharing project cost sharing for the General Navigation Features (GNFs) for the Recommended Plan will be as follows:

1. Ten percent of the costs attributable to dredging to a depth not in excess of 20 feet; plus

2. Twenty-five percent of the costs attributable to dredging to a depth in excess of 20 feet, but not in excess of 45 feet; plus

3. Fifty percent of the costs attributable to dredging to a depth in excess of 45 feet;

4. Pay with interest, over a period not to exceed 30 years following completion of the period of construction of the project, up to an additional 10 percent of the total cost of construction of GNFs. The value of lands, easements, rights-of-way, relocations, and

deep-draft utility relocations provided by the non-Federal sponsor for the GNFs may be credited toward this required payment.

Project cost sharing for the maintenance of the GNFs will be as follows:

1. The non-Federal sponsor will provide 50 percent of the excess cost of O&M of the project over that cost that the Secretary determines would be incurred for O&M if the project had a depth of 45 feet.

2. The Federal share of O&M of GNFs of less than 45 feet is 100 percent.

3. The costs of disposal facilities for O&M are shared as GNFs.

12.7 COSTS FOR THE RECOMMENDED PLAN

The total cost for the Recommended Plan is $290,652,000, as shown in Table 73. Costs include implementation costs and associated costs. Implementation costs include postauthorization planning and design costs, construction costs, construction contingency costs, and O&M costs. Construction costs include costs for dredging and placement area construction. Costs for fish and wildlife mitigation are also included. No cultural resource mitigation costs are expected at this time. A programmatic agreement is in effect for any cultural resource mitigation, if required at a later date. Aids to navigation (estimated at $1,352,000) are provided by the USCG and are a Federal cost included in the economic justification, but are not subject to project cost sharing. Construction General funding will fund Federal share of all project construction.

Project costs and price escalation (calculated by estimating the midpoint of the proposed contracts) are combined to create the Fully Funded Cost. The Project First Cost for all project components is separated into expected non-Federal and Federal cost shares and detailed in Table 74. These costs differ from those in Table 73 due to the inclusion of PED and Construction Management costs across the different channel segments. These costs are accurate at different cost share rates based on the work being done at different depths. For a majority of the work where the existing channel is currently at –45-foot MLT (–46-foot MLLW), the work will be cost shared 50 percent Federal/50 percent non-Federal. On the Stauffer Channel where the existing depths are less than 20 feet and depths are proposed to go to –50-foot MLT (–51-foot MLLW), cost share will cover all levels including 90/10 Federal/non-Federal, 75/25, and 50/50. Where Stauffer Channel is proposed to go to –25-foot MLT (–26-foot MLLW), cost share will cover both the 90/10 and 75/25.

Table 73
Recommended Plan Cost
Comparison of Costs (rounded)

Cost Account	Item Description	First Cost ($) (Oct 11 Price Level)	Fully Funded Cost ($) (Oct 11 Price Level)
Federal Construction Cost			
01	Lands & Damages	-0-	-0-
06	Fish & Wildlife Facilities	161,000	180,000
12	Navigation Ports & Harbors	203,389,000	219,370,000
30	Planning, Engineering & Design	17,726,000	19,606,000
31	Construction Management	9,192,000	10,595,000
Federal Construction		**230,468,000**	**249,751,000**
Non-Federal (LERs/ Associated) Cost			
01	Lands & Damages	1,653,000	1,753,000
02	Relocations	-0-	-0-
12	Navigation Ports & Harbors (1)	57,179,000	61,829,000
12	Aids to Navigation	1,352,000	1,456,000
Non-Federal Construction		**58,832,000**	**63,582,000**
Aids to Navigation		**1,352,000**	**1,456,000**
Total Navigation Costs		**290,652,000**	**314,788,000**

(1) Costs include $38,800,000 in non-Federal bulkhead modifications and 18,379,000 in dredging costs for berthing areas adjacent to the Federal channel.

Table 74
Cost Apportionment

Cost Apportionment Navigation*	First Cost ($)	Fully Funded Cost ($)
Federal Navigation:		
Freeport Channel	108,029,000	115,262,000
Lower Stauffer Channel	7,520,000	7,958,000
Upper Stauffer Channel	2,719,000	2,876,000
Lands & Damages	-0-	-0-
Mitigation	134,000	142,000
Total Federal Navigation	**118,402,000**	**126,238,000**
non-Federal Navigation:		
Freeport Channel	108,029,000	115,262,000
Lower Stauffer Channel	3,104,000	3,284,000
Upper Stauffer Channel	806,000	852,000
Land & Damages	1,653,000	1,713,000
Mitigation	127,000	136,000
Total non-Federal Navigation	**113,719,000**	**121,247,000**
Total Navigation	**232,121,000**	**247,485,000**

*Costs include Preconstruction Engineering & Design and Construction Management totals.

The maintenance of project features will be funded through annual appropriations of the O&M program. The actual amounts will vary on a year-to-year basis because of variability in the volume of material removed during each dredging cycle and the variability of the cycles. Costs for maintenance of the Freeport Harbor Project will be in accordance with Section 101(b) of WRDA 86 (Planning Guidance Letter [PGL] 47, Cost Sharing for Dredged Material Disposal Facilities and Dredged Material Disposal Facility Partnerships), which allocates the increment of costs for maintenance of channel depths less than 45 feet as 100 percent Federal and the increment of costs for channel depths greater than 45 feet as 50 percent non-Federal and 50 percent Federal.

Additional PA capacity for the Recommended Plan will be constructed regularly over the 50-year period of analysis in conjunction with maintenance dredging cycles. Costs for disposal facility maintenance associated with the project will be allocated as 50 percent non-Federal and 50 percent Federal for the incremental cost associated with depths over 45 feet and 100 percent Federal for depths less than 45 feet.

The USCG is responsible for aids to navigation, and the cost is allocated as a Federal expense because the installation of new navigation aids on the Outer Bar Channel Extension and the Outer Bar Channel is related to deepening and widening and the replacement of navigation aids on the channel.

12.8 COST-SHARING APPORTIONMENT

The project cost for determining the cost-sharing requirements is based on the Project First Cost. This differs from the cost estimate that was utilized for the economic analysis that determined project benefits and the BCR.

GNF costs for deepening greater than 45 feet are cost shared at 50 percent non-Federal and 50 percent Federal. GNF costs for deepening between 25 and 45 feet are cost shared at 75 percent non-Federal and 25 percent Federal, and costs for deepening in depths less than 20 feet are cost shared at 90 percent Federal and 10 percent non-Federal. A majority of the dredging is in areas where the current channel is already at 45 feet MLT (46 feet MLLW) so a majority of costs will be shared 50/50. Stauffer Channel, however, is currently at 18 feet MLT (19 feet MLLW), and these costs will be cost shared across all the cost share ratios. The costs are separated into expected Federal and non-Federal shares and detailed in Table 74. Fish and wildlife mitigation is considered a GNF and is cost shared in the same manner as other GNF costs. Mitigation is necessary due to the construction of new PAs. Mitigation costs have been apportioned according to the reaches that will utilize these new Pas, and the cost share has been designated appropriately. Should cultural resources data recovery be needed at a later date, it would be handled in accordance with PL 93-291 (Section 7), e.g., data recovery costs would be 100 percent Federal up to 1 percent of the total amount appropriated for the project.

Non-Federal costs include non-Federal sponsor and berthing/dock owner costs. The non-Federal sponsor is responsible for 100 percent of LERRs. All project construction is on lands that are currently owned by the non-Federal sponsor. Pipeline relocations are defined as “deep-draft utility relocations” pursuant to PGL 44. No pipeline relocations are anticipated. Owners of berth and dock facilities that require modification in conjunction with the project would be responsible for 100 percent of those associated costs. Berth deepening and structural modifications will be incurred and are included in the project cost (see Table 73). The USCG is responsible for 100 percent of the cost of aids to navigation.

12.9 ADDITIONAL NON-FEDERAL SPONSOR CASH CONTRIBUTION

Section 101 of PL 99-662 requires for all navigation channel depths that the non-Federal sponsor must provide an additional cash contribution equal to 10 percent of fully funded GNF costs (minus costs for LERRs). This total is detailed in Table 75 below. These costs may be paid over a period not to exceed 30 years.

Table 75
Total General Navigation Features Costs and Credits
(October 2011 Price Level)

Cost-Shared GNF	$245,772,000
10% of GNF	$24,577,200
Creditable Land Costs	$1,713,000
Creditable Difference	($22,864,200)

12.10 NON-FEDERAL SPONSOR VIEWS

The non-Federal sponsor for the existing project, Port Freeport, has actively participated in the entire planning process. Their primary concern has been to provide the community with a channel design, preferably 55 feet deep in the Main Channel and 50 feet in the Lower Stauffer Channel, to increase navigation efficiency and safety. Port Freeport is supportive of the Recommended Plan, the LPP, and has indicated a strong interest in beginning construction as soon as possible.

12.11 RECOMMENDED PLAN AND RECENT USACE INITIATIVES

As stated earlier, USACE has implemented the USACE Campaign Plan over the past few years. These initiatives were developed to ensure USACE success in the future by improving the current practices and decision-making processes of the USACE organization. The application of those principles as they relate to the Recommended Plan for Freeport Harbor is described below.

12.11.1 USACE Actions for Change as Reflected in the Campaign Plan

Engineering Sustainable Water Resource (integrated solutions, collaborative approaches, and streamlined processes)

- Freeport Harbor study analyzed potential effects over the study area.
- Construction of the mitigation site was developed for a 50-year period of analysis. Development and design of the site will address potential changes over time.
- The direct and indirect effects of the project on the environment were quantified using ecological modeling. Compensatory mitigation is provided in the Recommended Plan for all project impacts.
- All environmental impacts of the proposed project have been addressed and offset by mitigating for impacts.

- Project impacts were identified and type and location of the compensation to be performed. The recommended mitigation plan results in an excess of overall environmental benefits over impacts.
- Dredged material placement plans were analyzed to beneficially use the material to the benefit of the entire system (inshore and offshore) to the greatest extent possible. The ODMDSs are dispersive sites and will be beneficial in slowing shoreline erosion and littoral drift.
- Opportunities to beneficially use the large quantities of dredged material that would be generated by the project were explored. The needs of the project to find environmentally acceptable placement areas have been satisfied in the development of the PAs and ODMDSs.
- Close coordination among the USACE, non-Federal sponsor, resource agencies, and interested parties occurred throughout the study process. Interactions were professional and respectful, and opinions and expertise of others were obtained and utilized where appropriate. Coordination with the resource agencies and interested parties ensured that the spectrum of environmental habitats of the study and project area were adequately understood, impacts accurately identified, and appropriate amount and type of mitigation was developed.

Delivering Effective, Resilient, Sustainable Solutions (sustainable infrastructure, resilience, risk-formed strategy, innovative approaches)

- Developed plans over long-term, 50-year period of analysis.
- Utilized latest development in engineering, economic, and environmental modeling.
- Risk analyses conducted throughout the study are summarized in Section 12.2.
- Review and inspection of work will be conducted during design and construction.
- Project risks are communicated at public meetings and during the public review of the study findings. The public is allowed to comment and/or express concerns throughout the study process.
- Unlike flood risk management and hurricane protection projects, navigation projects involve minimal risk to the public.
- Independent review of the project documents and analyses was performed internally to the USACE and externally by professionals from academia and expert consultants. Comments from those reviews have been incorporated into the study documents, as appropriate.
- The expertise of State and Federal resource agency professionals familiar with the highly complex coastal ecosystems of Texas was integrally involved in the evaluation and development of plans to offset environmental impacts of the project.

13.0 SUMMARY OF COORDINATION, PUBLIC VIEWS, AND COMMENTS

13.1 OVERVIEW

Public input has been important in the overall planning process to assure that plans considered and developed were compatible with community and regional objectives. The primary purposes of public involvement are (1) to allow the public the opportunity to provide timely information to the USACE so that developed plans will reflect their preferences to the greatest extent possible, and (2) to provide a method by which the USACE can inform the public so that those who choose to participate in the project formulation and the planning process can do so with a relatively complete understanding about the issues, opportunities, and consequences associated with a study. A more-detailed description of the public involvement process and complete list of all comments can be found in Appendix A of the FEIS.

The various measures used during this study to assure open, two-way public communication included public notices, media interviews, and meetings with various interested parties. The feasibility phase was initiated with issuance of a Public Notice in December 2003, which presented a summary of the past and planned study activities for this study. This notice also discussed the study process, the specific problems in the channel, and various alternatives to be investigated. It invited all interested parties to provide input to the study beginning with a public meeting held January 15, 2004. Ongoing coordination with USFWS, TPWD, TCEQ, NMFS, the Texas SHPO, and other Federal and State resource agencies continued throughout the course of the study.

13.2 PUBLIC INVOLVEMENT

A Public Scoping Meeting was held on January 15, 2004, at the Lake Jackson Civic Center, Lake Jackson, Texas. The meeting was advertised and promoted in conjunction with the non-Federal sponsor, the Brazos River Harbor Navigation District (Port Freeport). Advertising and promotion activities were initiated at least 3 weeks in advance of the scoping meeting in two local community newspapers. The meeting was also aired by a local community radio station through public service announcements. In addition, a mailout was conducted utilizing public and environmental database information and mailing lists maintained by Port Freeport.

The purpose of the meeting was to inform stakeholders and interested parties about the Freeport Harbor navigation study, to outline the planning and feasibility study processes, to present the proposed project schedule, and to solicit public comments/input. Solicitation of public comments was a primary objective of the scoping meeting to ensure that significant issues relating to the Freeport Harbor navigation study were addressed, as required by NEPA. As such, meeting participants were specifically asked to identify environmental concerns, constraints, opportunities, and recommendations associated with proposed channel improvements. Meeting attendants included an elected official's representative, maritime industry representatives, a local environmentalist from the Freeport area, and the general public.

The USACE solicited both oral and written comments. A court reporter provided by the non-Federal sponsor documented oral comments. Generally, the attending public provided positive comments in support of the proposed project. However, the local environmentalist expressed concerns regarding potential negative impacts associated with proposed channel improvements. The assertion was the environmental community would probably oppose deepening beyond 50 feet, in an effort to avert similar plans and desires from competing Gulf ports, which if implemented could result in negative cumulative environmental impacts for the Gulf Coast region.

No oral comments were provided by Federal, State, or local resource agencies at the meeting, and no subsequent written comments were received within the allotted comment period. No further public comment has been provided to date from stakeholders or other interested parties.

Two additional public information meetings have been held. One was held in February 2006 to inform the public of study progress and the last was held in February 2008 to inform the public of the study results. No issues were raised at the meetings.

On January 13, 2011, the final public meeting was held. The purposes of the meeting were to present project information and accept public comments on the final draft documents that were released for public review on December 23, 2010. Three public comments were made on the project. Several comments were received by comments cards and mailed statements.

14.0 RECOMMENDATIONS

14.1 OVERVIEW

It is recommended that the existing projects for Freeport Harbor, Texas, authorized by the RHA of 1970, be modified generally as described in this report as the Recommended Plan, with such modifications as in the discretion of the Chief of Engineers may be advisable, and subject to cost-sharing and financing arrangements satisfactory to the President and the Congress, to provide deep-draft channel improvements to the Port of Freeport from the enlargement and continued maintenance of a portion of the Freeport Harbor.

For the purpose of calculating the Section 902 limit, the total estimated first cost of the project is $232.1 million including an estimated Federal share of $118.4 million and an estimated non-Federal share of $113.7 million. The Project Cost of all project components, minus inflation and interest during construction, totals $290,652,000. The LPP Investment Cost of all components totals $309,952,000 and includes $19,305,000 in interest during construction for project components. Total average annual costs for the project are $25,068,000, which includes $14,434,000 in average annual costs for construction and $10,635,000 incremental annual O&M costs. The Federal government would be responsible for $5,466,000 of the incremental operations and maintenance costs and the non-Federal sponsor would be responsible for the remaining $5,169,000. Fully Funded Cost of the project, which includes Project Costs and expected escalation totals, is $314,788,000.

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

Port Freeport shall:

a. Provide 10 percent of the total cost of construction of the GNF 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 45 feet; plus 50 percent of the total cost of construction of the GNFs attributable to dredging to a depth in excess of 45 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 the first year of construction, any additional funds necessary to pay the full non-Federal share of design costs allocated by the Government to commercial navigation;

(3) 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 45 feet; plus 50 percent of the total cost of construction of the GNFs attributable to dredging to a depth in excess of 45 feet;

b. Provide all lands, easement, and rights-of-way (LER), 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 non-Federal sponsor 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 non-Federal sponsor equals or exceeds 10 percent of the total cost of construction of the GNF, the non-Federal sponsor 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. Provide 50 percent of the excess cost of O&M of the project over that cost which the Government determines would be incurred for O&M if the project had a depth of 45 feet;

f. Give the Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsor owns or controls for access to the project for the purpose of completing, inspecting, operating, and maintaining the GNFs;

g. Hold and save the United States free from all damages arising from the construction or O&M 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;

h. 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 CFR, Section 33.20;

i. 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 USC 9601–9675, that may exist in, on, or under LER that the Government determines to be necessary for the construction or O&M 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 investigation unless the Government provides the non-Federal sponsor with prior specific written direction, in which case the non-Federal sponsor shall perform such investigations in accordance with such written direction;

j. Assume complete financial responsibility, as between the Government and the non-Federal sponsor, for all necessary cleanup and response costs of any hazardous substances regulated under CERCLA that are located in, on, or under LER that the Government determines to be necessary for the construction or O&M of the project;

k. To the maximum extent practicable, perform its obligations in a manner that will not cause liability to arise under CERCLA;

l. Comply with Section 221 of PL 91-611, Flood Control Act of 1970, as amended, (42 USC 1962d-5b) and Section 101(e) of the WRDA 86, PL 99-662, as amended, (33 USC 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 non-Federal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element;

m. Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, PL 91-646, as amended, (42 USC 4601-4655) and the Uniform Regulations contained in 49 CFR 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;

n. Comply with all applicable Federal and State laws and regulations, including, but not limited to, Section 601 of the Civil Rights Act of 1964, PL 88-352 (42 USC 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 USC 3141-3148 and 40 USC 3701-3708 (revising, codifying and enacting without substantive changes the provision of the Davis-Bacon Act (formerly 40 USC 276a et seq.), the Contract Work Hours and Safety Standards Act (formerly 40 USC 327 et seq.), and the Copeland Anti-Kickback Act (formerly 40 USC 276c);

o. 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 1 percent of the total amount authorized to be appropriated for the project;

p Not use funds from other Federal programs, including any non-Federal contribution required as a matching share therefore, to meet any of the non-Federal sponsor'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; and

q. Substantially complete the first phase of the Velasco Container Terminal (800-foot berth and 35 acres of supporting backland) on the Stauffer Channel prior to the initiation of construction of the Stauffer Channel portion of the project.

Construction of the recommended channel improvements is estimated to take 5 years to complete. During this period, the Government and the non-Federal sponsor 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.

Those portions of the projects for the Freeport Harbor and Stauffer channels that are deepened or newly created shall be operated and maintained according to the terms and provision of the new agreements. All other portions of the existing projects for the Stauffer Channel shall continue to be operated and maintained according to the existing agreement applicable to that portion of the channel.

The recommendations contained herein reflect no current removal of pipelines. Pipeline removal/relocation is recommended, in most cases, for pipelines with less than 20 feet of cover after project construction over the width of the channel plus an additional 25 feet of width on each channel edge. It is proposed that all of the lines remain at their current depth based on several criteria, including type of product transported in the line, whether the line has a casing, type of material the line is buried in, and scour in the portion of the channel the line is located in. Based on these considerations, all pipelines after project construction will remain at their current depth. Additional consideration will be given to cover requirements during design of the project. Should the decision be made that more cover is needed on lines not previously scheduled for removal, the District Engineer will update the project economic evaluation to reflect the cost, no changes to the Baseline Cost Estimate or Sponsor and Federal cost-sharing will be required.

14.2 RECOMMENDATION

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 non-Federal sponsor, the State, interested Federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

16 July 2012
Date

Christopher W. Sallese
Colonel, Corps of Engineers
District Engineer

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