US Army Corps of Engineers
Galveston District

VOLUME II

FINAL

FREEPORT HARBOR, TEXAS

CHANNEL IMPROVEMENT PROJECT

FEASIBILITY REPORT

September 2012

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Acronyms and Abbreviations

AAE	average annual equivalent
AEO	Annual Energy Outlook
ARRA	American Recovery and Reinvestment Act
BCR	benefit to cost ratio
BNSF	Burlington Northern Santa Fe Railway
BP	British Petroleum
BPD	barrels per day
BRPA	Brazos River Pilots Association
CFR	Code of Federal Regulations
DC	distribution center
DOE	U.S. Department of Energy
DWT	deadweight ton
EGM	Economic Guidance Memorandum
EIA	Energy Information Administration
ERDC	Engineer Research and Development Center
FM	Farm-to-Market Road
FTZ	foreign trade zone
FY	fiscal year
GAO	U.S. General Accounting Office
GDP	gross domestic product
GIWW	Gulf Intracoastal Waterway
HP	Horsepower
IWR	Institute of Water Resources
KCSR	Kansas City Southern Railroad
LA/LB	Los Angeles/Long Beach
LNG	liquefied natural gas
LOA	length overall
LoLo	load-on/load-off
LPP	locally preferred plan
m^3	cubic meters
MMS	Minerals Management Service, now the Bureau of Ocean Energy Management (BOEM) and the Bureau of Safety and Environmental Enforcement (BSEE)
NDC	Navigation Data Center
NED	National Economic Development
NGL	natural gas liquids
O&M	operation and maintenance
OSV	offshore supply vessel

Acronyms and Abbreviations, cont’d

PADD	Petroleum Administration for Defense District
PSV	Platform Supply Vessel
SH	State Highway
SPR	Strategic Petroleum Reserve Storage
TEPPCO	Texas Eastern Petroleum Pipeline Company
TEU	twenty-foot equivalent unit
TexMex	Texas Mexican Railway Company
TIP	Transportation Improvement Program
TOPS	Texas Offshore Oil Port System
TxDOT	Texas Department of Transportation
UP	Union Pacific Railway
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
VLCC	very large crude carrier
WCSC	Waterborne Commerce Statistical Center
WRDA	Water Resources Development Act

1.0 OVERVIEW

This appendix presents the economic analysis for the Freeport Channel Feasibility Study. The project benefits were calculated based on reductions in transportation costs generated from more-efficient vessel loading and from reductions in vessel delays. The benefits were calculated for a 2017 to 2067 period of analysis using fiscal year (FY) 2012 Federal discount rate of 4.0 percent and the deep-draft vessel operating costs contained in the Economic Guidance Memorandum (EGM 11-05). The proposed channel improvements are in response to the need for deeper access by allowing the existing fleet to load more fully, for the introduction of larger vessels, and the reauthorization of the upper reaches of the harbor.

The existing Federal project includes a 47- by 400-foot offshore Entrance Channel, a 45-foot by 400-foot Main Channel, and 36-foot depth to its general cargo docks. Figure 1-1 displays the navigation channel and associated features. Figure 1-2 shows the major terminals. The existing project extends approximately 9.7 miles from its offshore entrance 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, intersects 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. Freeport’s 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 Public Law 251. Since deauthorization, the channel depth deteriorated from 25 feet to an approximate 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.

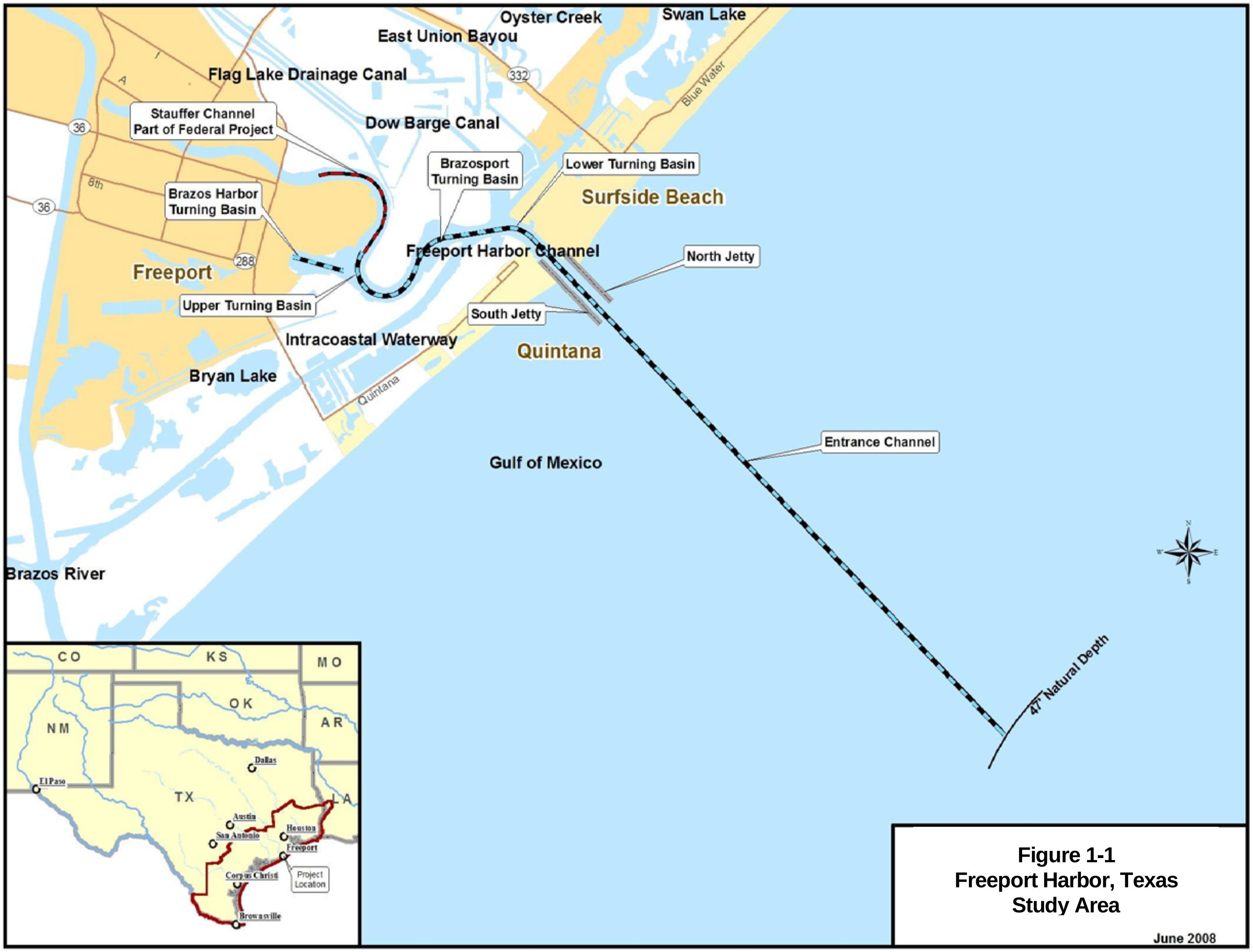
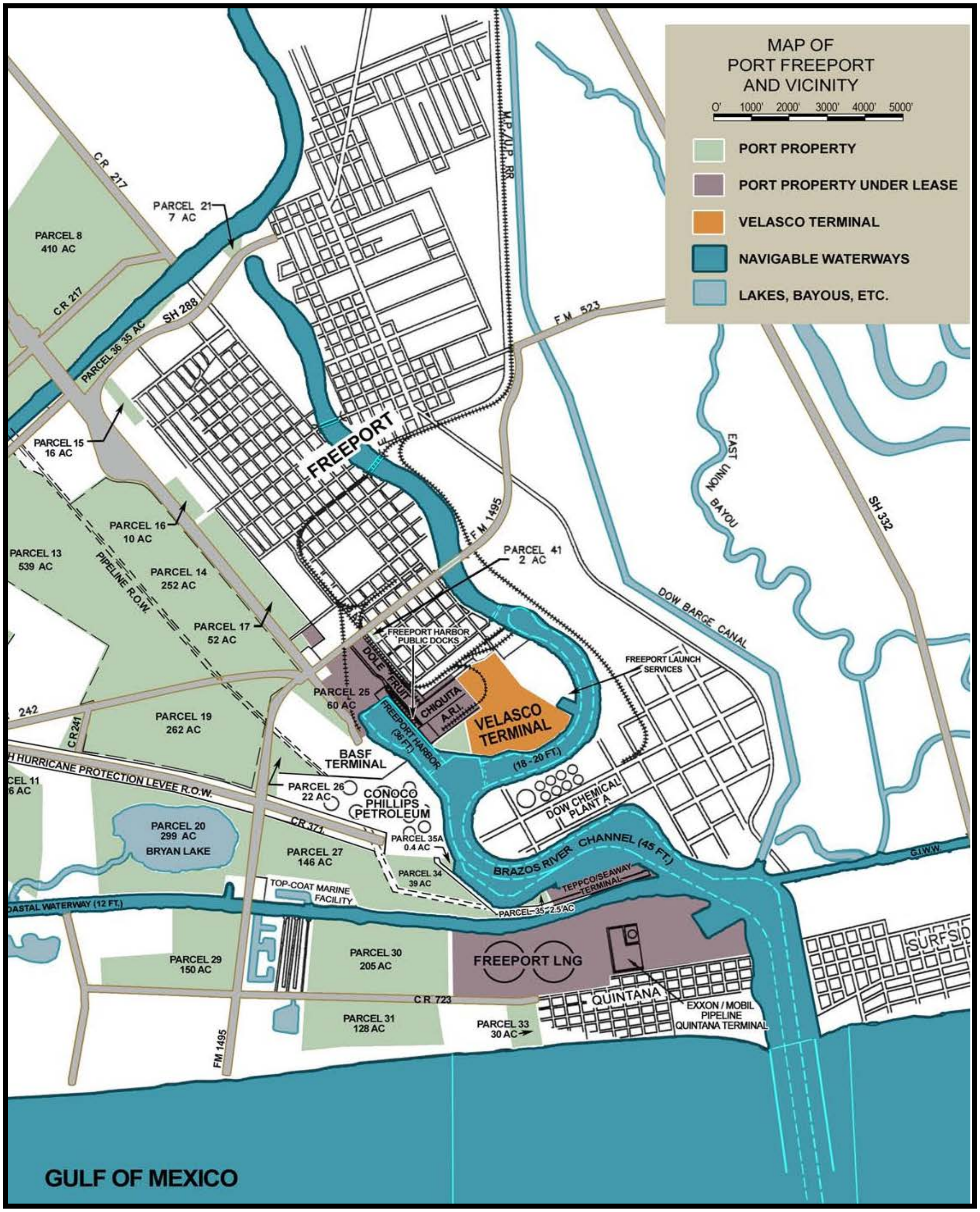


Figure 1-1
Freeport Harbor, Texas
Study Area

June 2008

Figure 1-2
Freeport Harbor Facilities



1.1 OVERVIEW OF CHANNEL REACHES

The existing Federal project contains three operational reaches and one deauthorized reach. Figure 1-3 shows the reaches used in the economic analysis. The first economic reach is a combination of the first two operational reaches and starts offshore at Station –370+00 and goes to Station 132+66. This reach 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 and chemical tankers using docks operated by Dow Chemical. The maximum-sized vessels using Seaway on a regular basis are 820-foot-long by 145-foot-wide crude oil tankers. The length and beam of these vessels generally correspond to a 120,000-deadweight ton (DWT) vessel. The chemical carriers typically 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. Nearly 10 percent of recent tonnage was loaded to 40–43 feet, with only a few at 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. This compares with a review in 2004/2005 that showed 2.6 percent of chemical tankers built after 1995 having design drafts of 42 feet and less than 1 percent with design drafts over 42 feet. Freeport's liquefied natural gas (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 Gulf Intracoastal Waterway (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 Water Resources Development Act (WRDA) of 1986 as amended in 1990.

The second major reach of the channel extends from near the Brazosport Turning Basin to the Upper Turning Basin near Station 184+20. The Upper Turning Basin is approximately 750 feet in diameter. The major terminal includes ConocoPhillips. Vessel traffic consists of product carriers and crude petroleum tankers. The largest vessels using this upper reach are approximately 100,000 DWT crude petroleum tankers.

Part of the third 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 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 new Velasco Container Terminal.

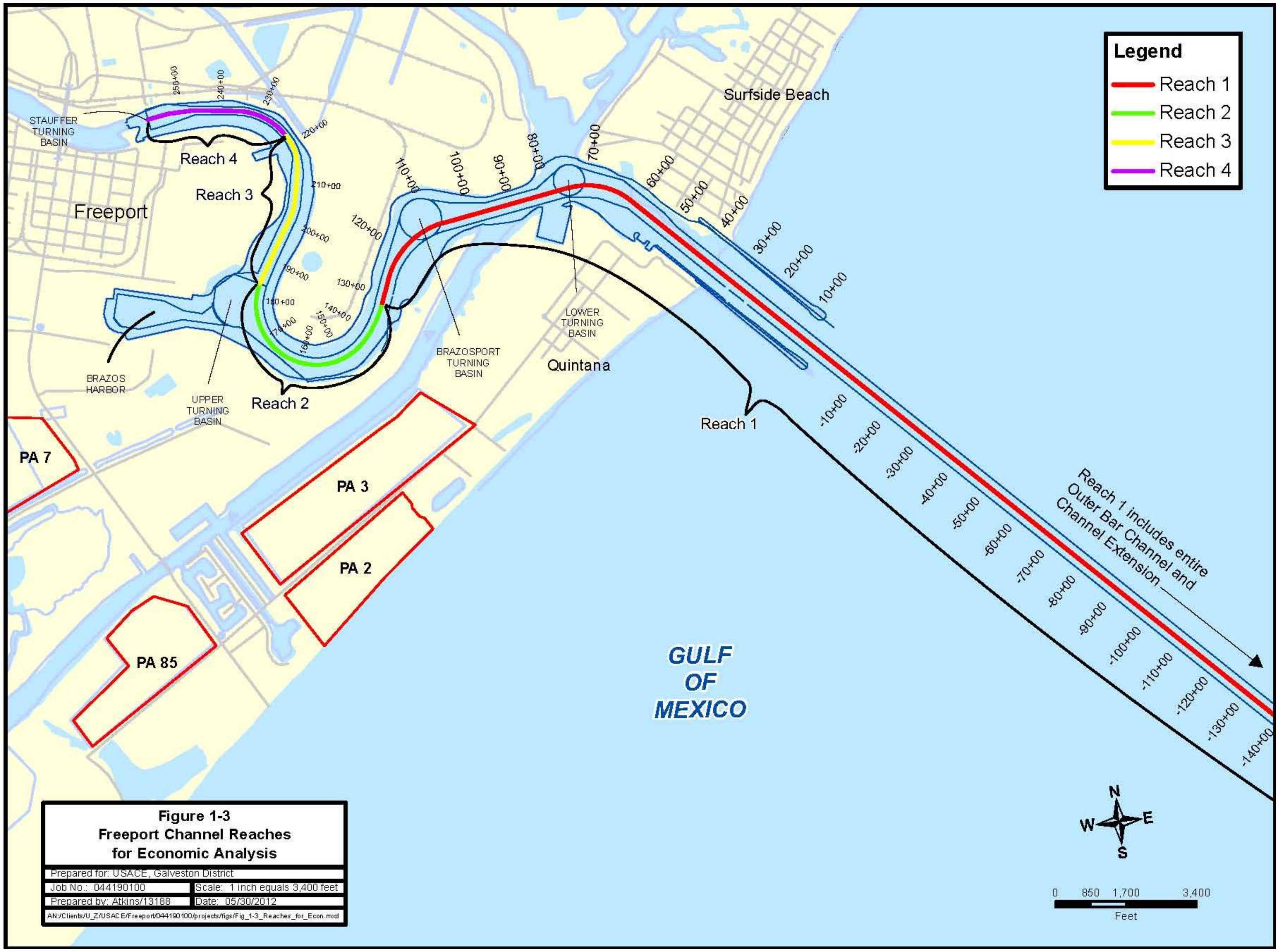


Figure 1-3
Freeport Channel Reaches for Economic Analysis

The third and fourth economic reaches contain 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 Station 222+00 to 260+00 and is just below the Freeport Tide Gate.

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, Public Law 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 Station 184+20 to 260+00.

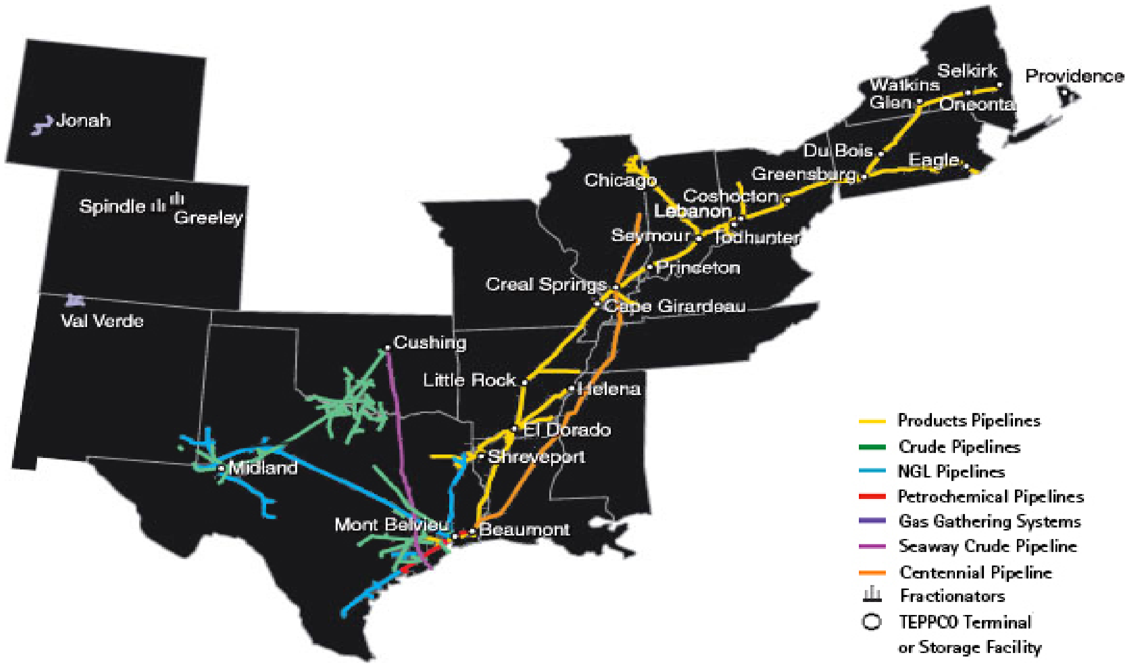
The existing Federal project includes four turning basins. The Lower Turning Basin is 750 feet in diameter and located near Station 70+00. Next is the Brazosport Turning Basin, which is 1,000 feet in diameter and is located near Station 110+00. The Brazos Harbor Turning Basin is 750 feet in diameter 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.

1.2 OVERVIEW OF EXISTING INFRASTRUCTURE AND COMMODITIES

The Seaway Terminal is located at the lower end of the channel near Channel Station 115+00. Seaway Crude Pipeline Company is a partnership between wholly owned subsidiaries of Texas Eastern Petroleum Pipeline Company (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. During the 1990s, partnerships among ConocoPhillips, 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 to 2.6 million barrels. The expansion increased the capacity of the Seaway crude system from approximately 223,000 barrels per day (BPD) to a volume of 260,000 BPD. Today, 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. Also, a natural gas liquids (NGL) processing unit and olefins plant, jointly owned and operated by Chevron and Phillips, is located at the Sweeny complex. Figure 1-4 shows the regional pipeline network served by Freeport.

Figure 1-4
Freeport Pipeline Inputs and Output Network



Freeport's crude petroleum terminals also transmit crude oil to the Bryan Mound Strategic Petroleum Reserve Storage (SPR) Site. The Strategic Petroleum Reserve 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. One of those sites, Bryan Mound, is located 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 dock, and a 46-inch line to Sweeny and Texas City, Houston, and the Midwest. Figure 1-5 shows the SPR sites.

Freeport is contained in the U.S. Gulf Coast Petroleum Administration for Defense District (PADD III). PADD III includes the states of Texas, Louisiana, Arkansas, Mississippi, Alabama, and New Mexico. Figure 1-6 shows the U.S. PADD boundaries. Freeport's crude petroleum imports represent 4 percent of the U.S. total and 7 percent of the U.S. Gulf Coast PADD III region.

Figure 1-5
U.S. Strategic Petroleum Reserves Gulf Coast Sites

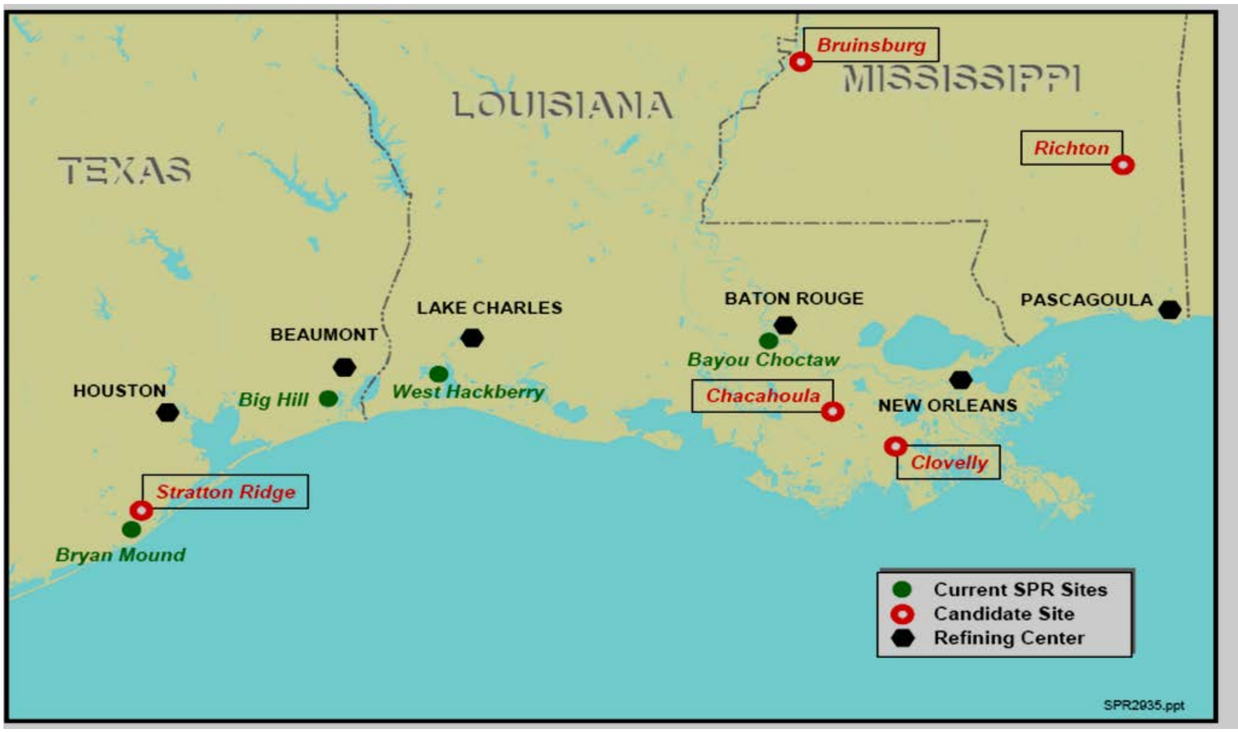
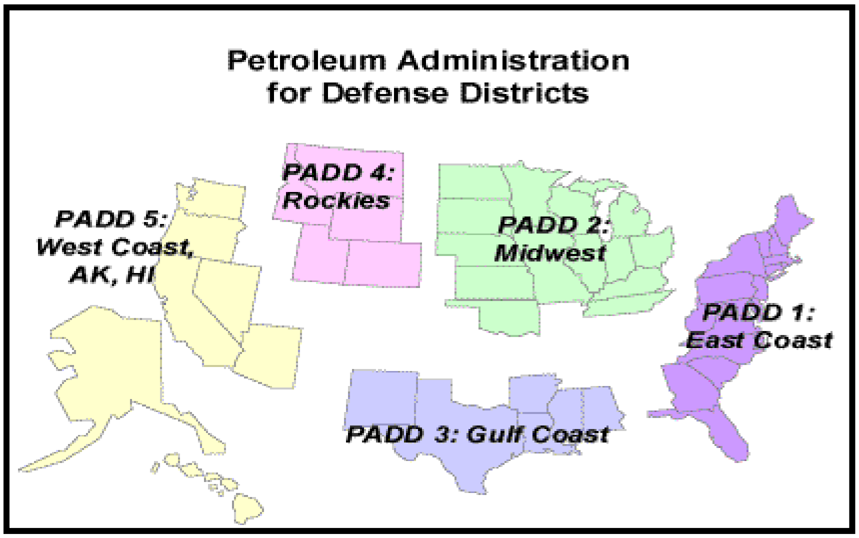


Figure 1-6
U.S. Petroleum Administration for Defense Districts



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.

While the majority of Freeport's cargo consists of crude oil, bulk fuels, and chemicals, the port has a large general cargo base that includes a variety of temperature-sensitive cargos such as meat and vegetables. Freeport is currently the only port in addition to Houston that regularly handles containerized cargo. Freeport's existing temperature-sensitive cargos, rice, and other general and containerized base cargo docks are located in the 36-foot-deep Brazos Harbor Turning Basin (Figure 1-7). 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 fruit distributors. Currently, Freeport's container trade is concentrated principally on fresh fruit by producers such as Dole, Chiquita, and Turbana. 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. In 2007, container throughput was approximately 60,000 twenty-foot equivalent units (TEU). Freeport maintains an abundance of container storage space and over 7,500 acres available for development.

The Velasco Container Terminal is in the lower reach of the Stauffer Channel (Figure 1-8). Construction of the Velasco Terminal was prompted by increasing existing traffic volumes and vessel size limitations, the inability to deepen the Brazos Harbor Turning Basin access area due to the threat of undermining wharfage, growth in the U.S. container market, and regional and state population growth. Access to the Velasco Terminal will require extending the Federal channel 3,700 feet from its current terminus. Work by the non-Federal sponsor is presently nearing completion on 800 feet (Phase I) of what will be 1,200 feet (Phase II) of dock, and 41 acres of backland of what will be a 90-acre terminal (Phase II). The first vessels are expected to utilize Phase I of the terminal by mid-2013. The current operating depth for the Federal channel at the lower part of the property adjacent to Velasco is 45 feet.

The Velasco Terminal is being constructed in partnership agreement with the Spanish-based Dragados SPL. Both the Velasco Terminal and existing container and general cargo facilities are within 8 miles of the open waters of the Gulf of Mexico. All of Freeport's docks are located within 4 miles from the GIWW.

Figure 1-7
Brazos Harbor Turning Basin Docks

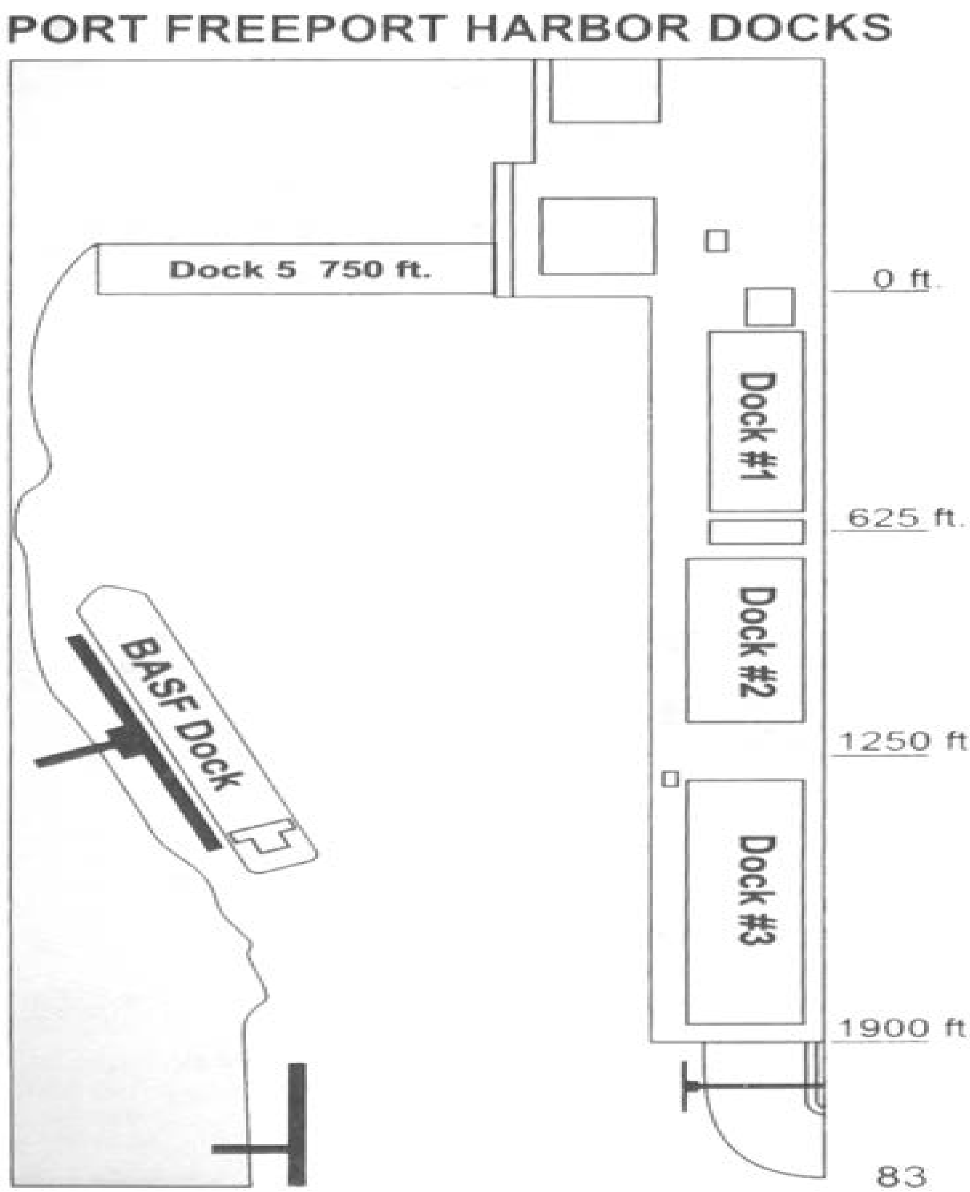
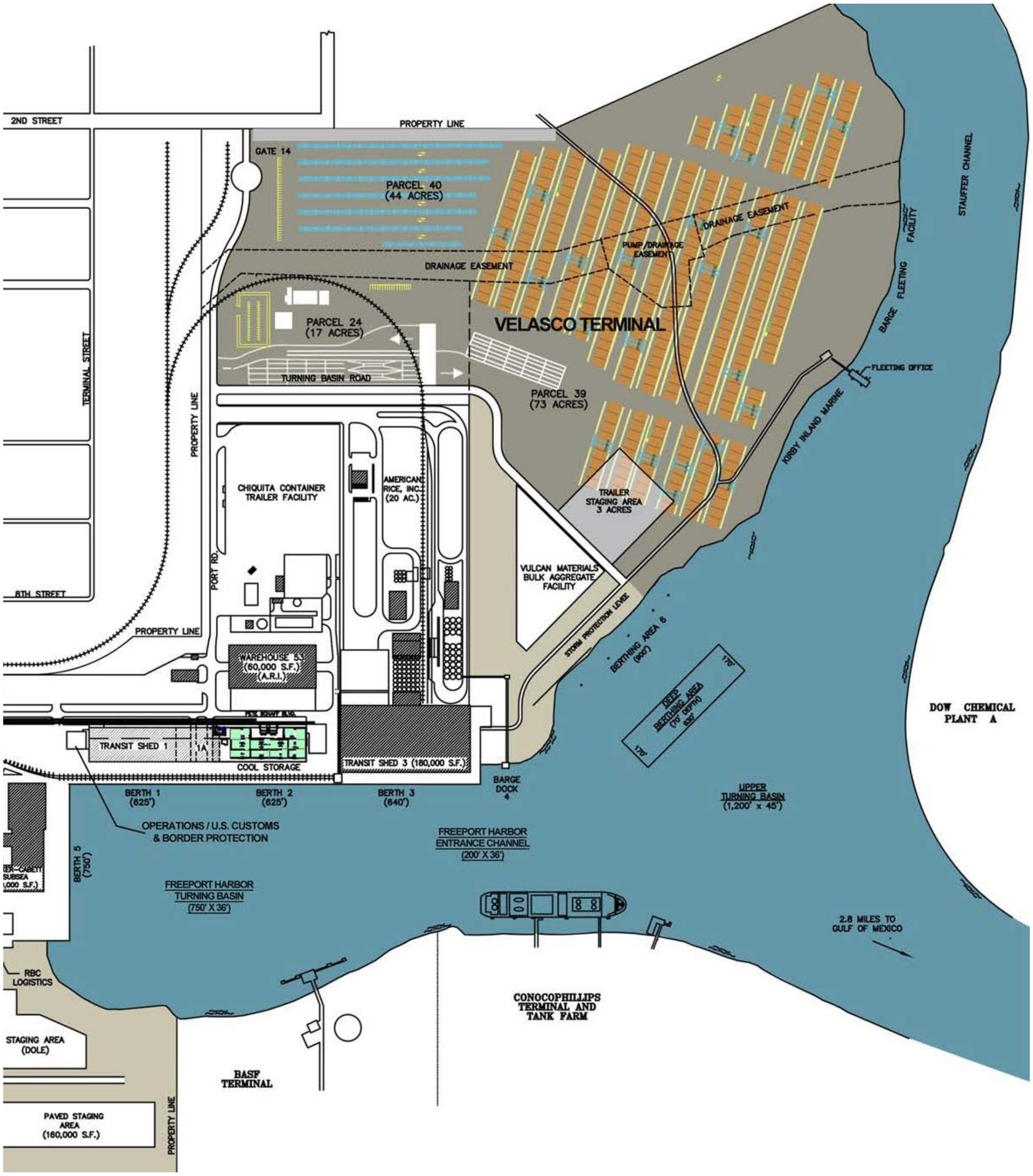


Figure 1-8
Velasco Terminal Site



The port's proximity to deep water provides efficient transportation to Houston and beyond via highway, rail, and the inland waterway system. The port is accessible from the landside by State Highway (SH) 36, SH 288, and Farm-to-Market Road (FM) 523. Road widening to four lanes from two lanes of SH 36 is in the Texas Department of Transportation's (TxDOT) Transportation Improvement Program (TIP). SH 36 provides a direct access to U.S. Highway 90 and Interstate 10, which provides direct access to San Antonio. SH 288 is accessible going northward from the port on SH 332, turning into SH 288 north of Lake Jackson. The right-of-way for FM 2004, which is presently two lanes, will accommodate four lanes. FM 2004, which intersects with SH 288 north of Lake Jackson, goes from Freeport to Interstate 45. Interstate 45 provides direct access from Houston to Dallas. Figure 1-9 shows the highway network around Freeport.

Figure 1-9
Regional Highway System

Source: mapplus.com

Port officials are working with the Texas Transportation Commission on advancing both highway and railway improvement. Table 1-1 provides information on TxDOT highway improvement projects for the roads serving the port.

Efficient rail access is also important to container ports. Three Class 1 railroads operated 81 percent of Texas's total track miles in 2003. Class 1 represents the major railroad companies moving significant amounts of freight over long distances and owning track spanning several states. The three Class I railroads serving Texas are Burlington Northern Santa Fe Railway (BNSF), Kansas City Southern Railroad (KCSR), and Union Pacific (UP).

Table 1-1
Brazoria County Texas Department of Transportation (TxDOT)
Planned Road Improvement Projects

Road Type	Length (Miles)	Currently Funded (Y/N)	Starting Location[a]	Ending Location[a]	Project Type
SH 36	1.239	N	0.9 mile S. of the Brazos River	FM 1495	Widen roadway
SH 36	0.001	N	FM 1495	.	Construct overpass/ underpass
SH 36	2.936	Y	S. of Jones Creek Bridge	0.2 mile N. of the Brazos River Diversion Channel	Widen roadway
SH 36	0.001	N	SH 36 at the Brazos River		Install/upgrade safety barrier
FM 1495	0.001	N	GIWW at the Brazos River		Repair bridge
FM 521	0.001	Y	Brazos River and SH 332	.	Repair bridge
FM 523	1.096	N	SH 332	Dow Waste Water Canal	Resurface roadway
SH 332	1.383	N	0.657 mile N. of Plantation Dr.	0.726 mile S. of Plantation Dr.	Construct overpass/ underpass
SH 332	0.966	N	0.480 mile N. of Dixie Dr.	0.466 mile S. of Dixie Dr.	Construct overpass/ underpass
SH 332	0.889	N	0.492 mile N. of Main Street	0.397 mile S. of Main St.	Construct overpass/ underpass
Within 5 miles of the Port, Moving West to the Junction of SH 35 with SH 36					
SH 35	0.452	N	BS 288B	Rock Island Street Junction with SH 288	Widen roadway
SH 35	3.210	N	Rock Island St. Junction with SH 288	FM 523	Widen roadway
SH 35	0.926	N	SH 288	T.J. Wright St.	Widen roadway
Greater than 5 miles from the Port, Moving Northwest to Interstate 10					
SH 36	9.644	Y	S. of Brazoria	S. of Jones Creek Bridge	Widen roadway
SH 36	4.318	Y	FM 522	2.30 miles N. of SH 332	Widen roadway
SH 36	1.799	Y	SH 35	FM 522	Widen roadway
SH 36	14.005	Y	Fort Bend County Line	SH 35	Widen roadway
CR	0.083	Y	CR 703 at Draw	.	Replace bridge
SH 288	0.641	Y	CR 101 (Bailey Rd.)	.	Construct overpass/ underpass
FM 521	0.001	Y	Brazos River and SH 332	.	Repair bridge
CR	0.073	Y	CR 121 at Hayes Creek	.	Replace bridge
FM 523	1.241	N	SH 332	0.2 mile S. of FM 1495	Widen roadway
FM 2234	2.244	N	Fort Bend County Line	SH 288	Widen roadway
Greater than 5 miles from the Port, Moving Northwest to Interstate 45					
FM 2004	2.701	N	SH 288	BS 288	Widen roadway
FM 2004	2.517	N	Chocolate Bayou	New Bayou	Widen roadway

Source: Compiled from TxDOT Database, March 2010.
[a]As defined by TxDOT.

While improvements have been made, conditions of U.S. railroads vary widely and inefficiencies are frequently cited in relation to container cargo distribution. The emphasis on “just in time delivery” cited by many and growing congestion at existing ports and landside transportation networks has prompted growth at smaller and new ports, and contributed to the higher growth rates on the U.S. Gulf and East coasts.

In 2005, the Surface Transportation Board approved the acquisition of abandoned tracks from Victoria to Rosenberg, and improvements to the rail line were completed in June 2009. Prior to 2009, rail traffic followed lines parallel to SH 77 through Victoria to Halletsville, before moving east to Rosenberg on a line paralleling US 90A. The 84.5-mile reactivated rail line parallels SH 59 and is located in the Texas counties of Jackson, Victoria, Wharton, and Fort Bend. These counties border Brazoria County. The rehabilitation of the KCSR line between Victoria and Rosenberg shortened the rail distance from Mexico by approximately 70 miles by eliminating the need for KCSR to operate over nearly 160 miles of Union Pacific–controlled track between Rosenberg and Victoria via Flatonia, which is a heavily used rail corridor. The rehabilitation of the Victoria-Rosenberg line facilitated CenterPoint Properties, and the KCSR recently completed construction of an estimated 636-acre intermodal logistics park (CenterPoint Intermodal Center). This property will be used to facilitate receive, store, and disburse rail and truck containerized cargo (foreign trade zone [FTZ] 149, Site 12).

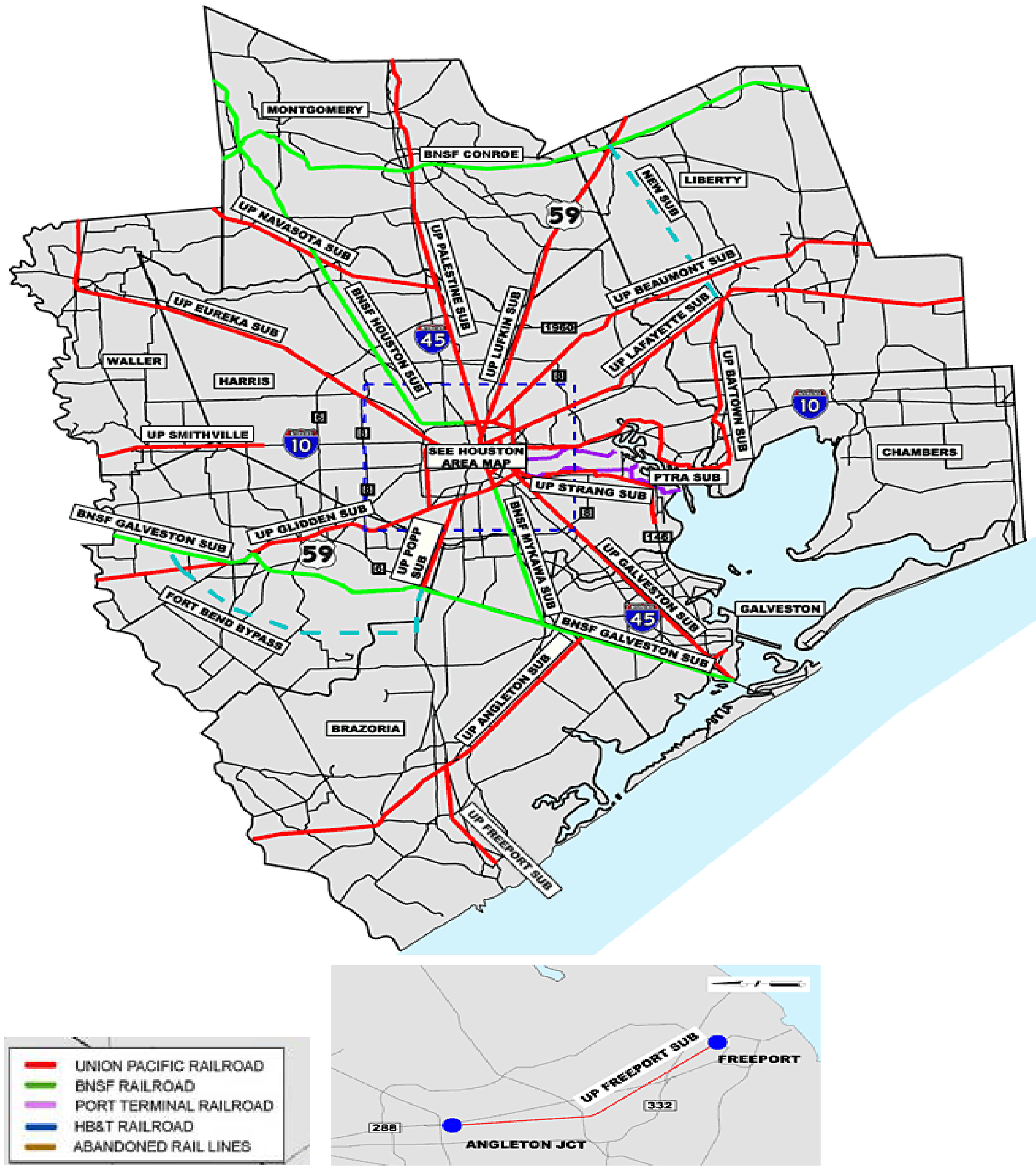
The specific location of the intermodal yard is 35 miles southwest of Houston and immediately south of Kendleton. The recently completed facility includes a 3,500-foot intermodal track with associated parking and facilities. Additional adjacent development will include the 340-acre International Industrial Park (FTZ 149, Site 11) being developed by GBI Group, LLC. Sites 11 and 12 are 61.5 miles from Freeport Velasco Container Terminal and 64 miles from Barbours Cut on the Houston Ship Channel.

UP has a direct connection to Freeport’s existing container and general yard site in the Brazosport Basin and Dow Chemical loading areas. The spur provides access to the main UP lines to San Antonio and the separate Houston line that provides connection to Dallas. Rail corridors on the east and west sides of Houston exist similar to the Los Angeles/Long Beach Alameda Rail Corridor, according to Port of Freeport personnel. Freeport is initially anticipated to serve as a truck port, but enhancements to rail capabilities in Brazoria County are planned, including replacement of a World War II–era rail bridge over the old Brazos River channel in downtown Freeport.

In addition to the Victoria to Rosenberg line, another KCSR line renovation from the Texas-Mexico border city of Laredo, Texas, and Corpus Christi, Texas, was recently completed. The *Houston Chronicle* noted that about six rail cars per day move between Lazaro Cardenas on Mexico’s Pacific Coast to Houston. KCSR also owns a subsidiary of the Texas Mexican Railway

Company (TexMex)[1]. The affiliation allows access to the Pacific and Gulf coasts of Mexico. Figure 1-10 provides a pictorial of the rail lines presently serving the Freeport study region.

Figure 1-10
Regional Railroad System



Source: TxDOT, Houston Freight Study, October 2005.

[1] Houston Chronicle, "Revived Route Connects Dots, Kansas City Southern Railway Cuts 67 Miles Off Vital Journey," June 18, 2009.

Table 1-2 displays mileages from Freeport to towns and cities within and adjacent to Brazoria County.

Table 1-2
Mileage Comparison to
Cities Within or Adjacent to Brazoria County

City	Freeport Miles	LaPorte Miles	Freeport Advantage Plus (+)	2008 City Population	County
Lake Jackson	10	64	54	27,614	Brazoria
Rosenberg	58	58	0	24,043	Ft. Bend
Bay City	49	90	41	18,667	Matagorda
Angleton	27	54	27	18,130	Brazoria
Freeport	0	74	74	12,708	Brazoria
El Campo	101	102	1	10,945	Wharton
Clute	8	69	61	10,424	Brazoria
Wharton	60	82	22	9,772	Wharton
Palacios	72	128	56	5,153	Matagorda
West Colombia	26	66	40	4,199	Brazoria
Sweeny	27	75	48	3,624	Brazoria
Brazoria	18	66	48	2,974	Brazoria
Jones Creek	8	72	64	2,130	Brazoria
Danbury	25	41	16	1,611	Brazoria

In addition to relative distances from Freeport, the locations of “distribution centers (DCs),” also referred to as “inland ports,” were examined. DCs used to function primarily as warehouses but currently are involved in repackaging cargo for retailers and adding value to commodities. These centers are established along supply chains to service retail outlets such as Wal-Mart, Target, Home Depot, and Lowes. The inland ports of Alliance (Forth Worth), Wilmer (Dallas), and Kelly (San Antonio) are part of the Texas freight distribution network. The inland ports complement the overland border ports of entry, where consolidation of trade transfers can take place related to the North Atlantic Free Trade Agreement.

The docks located in the Upper Stauffer channel reach are operated by Freeport Launch, VIT Marine, and Baron Marine. The Freeport Launch dock and yard are inside the U.S. Department of Homeland Security secured gated area adjacent to the channel. Since 2001, an estimated $100,000 was spent by industry to ensure that the Freeport Launch facility is in compliance with U.S. Homeland Security regulations associated with foreign flag vessel and associated crew activity. As a result of the Homeland Security upgrades, the boat yard includes gates and a guarded entrance with 24-hour security. VIT is located immediately north of Freeport Launch.

Both facilities are on the west side of the channel. Baron Marine is on the east side of the channel.

Freeport has an existing LNG facility that includes two 160,000-cubic-meter storage tanks and one piled dock capable of handling LNG vessels in excess of 200,000 cubic meters to accommodate the largest LNG tankers under construction today. Freeport's LNG terminal became operational in April 2008 and is located along the northern edge of the Freeport Harbor Entrance channel 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. The first phase of the project allows the facility to have a send-out capacity of 1.75 billion cubic feet per day. 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. Benefits from LNG are not captured in this analysis.

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2.0 HISTORICAL TRAFFIC

Freeport experienced strong growth over the past two decades. 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.

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 2-1 presents Freeport's 2006 imports and exports by foreign region of origin or destination. Table 2-2 presents Freeport's tonnage by major commodity groups through 2009.

Table 2-1
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: U.S. Army Corps of Engineers (USACE), NDC detailed unpublished data, 2006.

[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.

Table 2-2
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.

In addition to the commodity and container traffic, in 2008 Freeport handled 28,000 tons of wind energy equipment, and 21 vessels called at the port with wind-energy equipment.

2.1 CRUDE PETROLEUM IMPORT TRAFFIC

Crude petroleum dominates total tonnage. Crude petroleum represented 75 percent of 2004 to 2006 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 PADD III. The Seaway pipeline system provides a critical link in the crude oil supply chain for Central and Midwest refining centers.

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 combination of the channel-deepening project from 40 to 45 feet in the early nineties 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 IWR-WCSC-09 show Freeport's 2007 total tonnage at approximately 30 million short tons, down from 32 million in 2006. Data from the U.S. Department of Energy (DOE) show that Freeport's crude oil imports were down in both 2007 and 2008 from 2006 levels. 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 2-3 displays Freeport's crude petroleum imports and shows the port's share of the national and regional totals. Table 2-4 lists crude oil volumes imported to Freeport and distributed to regional and national domestic processing area. Table 2-5 indicates approximately 25 percent of the crude oil imported to Freeport is sent from PADD III to PADD II.

Table 2-3
Comparison of Freeport and Regional and National Totals
Crude Petroleum Imports (1,000s of short tons)

Year	Freeport Imports	Waterborne and Pipeline Imports		Freeport % of	
		PADD III	U.S. Total	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	548,742	6.0	3.6
2008	20,607	294,045	535,170	7.0	3.9
2009	19,418	278,454	493,030	7.0	3.9

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

Table 2-4
Freeport Crude Oil Imports by State and PADD Destination by Tonnage
1993 and 2003–2008 (1,000s of barrels)

Destination	1993	2003	2004	2005	2006	2007	2008
Illinois	0	12,995	6,998	4,583	14,262	11,606	14,849
Indiana	0	0	315	0	0	0	0
Kansas	0	1,910	16,144	10,546	7,969	792	1,539
Kentucky	0	0	540	0	0	0	0
Louisiana	0	0	0	1,447	1,204	0	0
Michigan	0	313	1,137	1,433	751	0	0
Minnesota	0	0	0	500	0	0	0
Ohio	0	0	0	500	0	0	0
Oklahoma	0	599	8,116	9,623	7,261	8,979	13,273
Texas	0	89,502	92,644	87,514	95,291	93,864	85,774
Beaumont	0	0	0	0	1,100	557	0
Borger	0	12,292	12,098	520	4,133	3,858	0
Houston	0	0	0	297	0	0	3,080
Sweeny	46,993	76,162	80,546	85,009	89,270	89,449	82,593
Texas City	0	525	0	1,688	395	0	101
Other	0	15,296	3,535	3,832	7,888	9,407	7,464
Freeport Total	46,993	120,615	129,429	119,978	134,626	124,648	122,899
PADD II	0	15,817	33,250	27,185	30,243	21,377	29,661
PADD III	46,993	104,275	96,179	92,793	103,990	103,271	93,238
Freeport Total	46,993	120,092	129,429	119,978	134,233	124,648	122,899
PADD II	0	13%	26%	23%	23%	17%	24%
PADD III	100%	87%	74%	77%	77%	83%	76%
Freeport Total	100%	100%	100%	100%	100%	100%	100%

Source: USACE and EIA, compiled from public website files, 1993 and 2003–2008.

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 Ship Channel. Approximately 90 percent of Freeport's total crude oil ship tonnage is discharged at Seaway, with the remaining 10 percent discharged at the ConocoPhillips dock.

The data presented in Tables 2-4 and 2-5 were compiled from the DOE's databases. The 2003 to 2006 annual EIA volumes show differences with the U.S. Army Corps of Engineers' (USACE) Navigation Data Center (NDC) data available for the same years. For instance, the NDC and the EIA 1993 to 2003 Freeport import rates of change are relatively similar, but comparison of Freeport's 2005 to 2008 rate of change shows imports decreasing and the EIA's rate shows an increase. The differences in the relative totals can be attributable to conversion factor applications based on the various properties of the different types of crude oil. The NDC data account for the specific crude types and their relative weights.

Table 2-5
Freeport Crude Oil Imports by State and PADD Destination by Percent
1993 and 2003–2008 (1,000s of barrels)

Destination	Percent						
	1993	2003	2004	2005	2006	2007	2008
Sweeny, TX (PADD III)	100.0	63.1	62.2	70.9	66.3	71.8	67.2
Wood River, IL (PADD II)	0.0	10.8	5.4	3.8	10.6	9.3	12.1
Ponca City, OK (PADD II)	0.0	0.5	6.3	8.0	5.4	4.5	6.7
Cushing, OK (PADD II)	0.0	0.0	0.0	0.0	0.0	2.7	4.1
Other	0.0	25.6	26.1	17.3	17.7	11.7	9.9
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: USACE and EIA, compiled from public website files.

Table 2-6 shows a comparison of the EIA and NDC data.

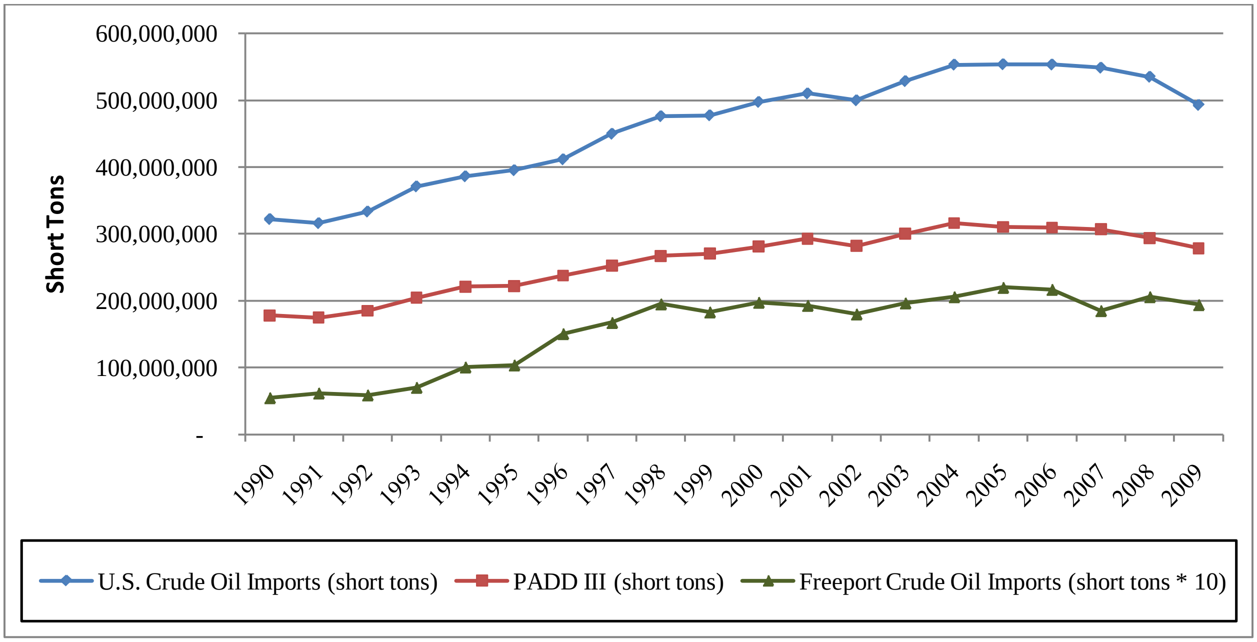
Table 2-6
Comparison of USACE and EIA Data
Freeport Crude Petroleum Imports

Year	Freeport Channel			
	NDC Short Tons	Factor Change	EIA Barrels[a]	Factor Change
1993	7,025		46,993	
2003	18,672	2.66	120,615	2.57
2004	20,602	1.05	129,685	1.08
2005	22,000	1.07	119,978	0.93
2006	21,706	0.99	134,233	1.12
2007	18,523	0.85	124,648	0.93
2008	20,607	1.12	122,899	0.99

Source: USACE and EIA, compiled from public website files.
[a]1,000s of barrels

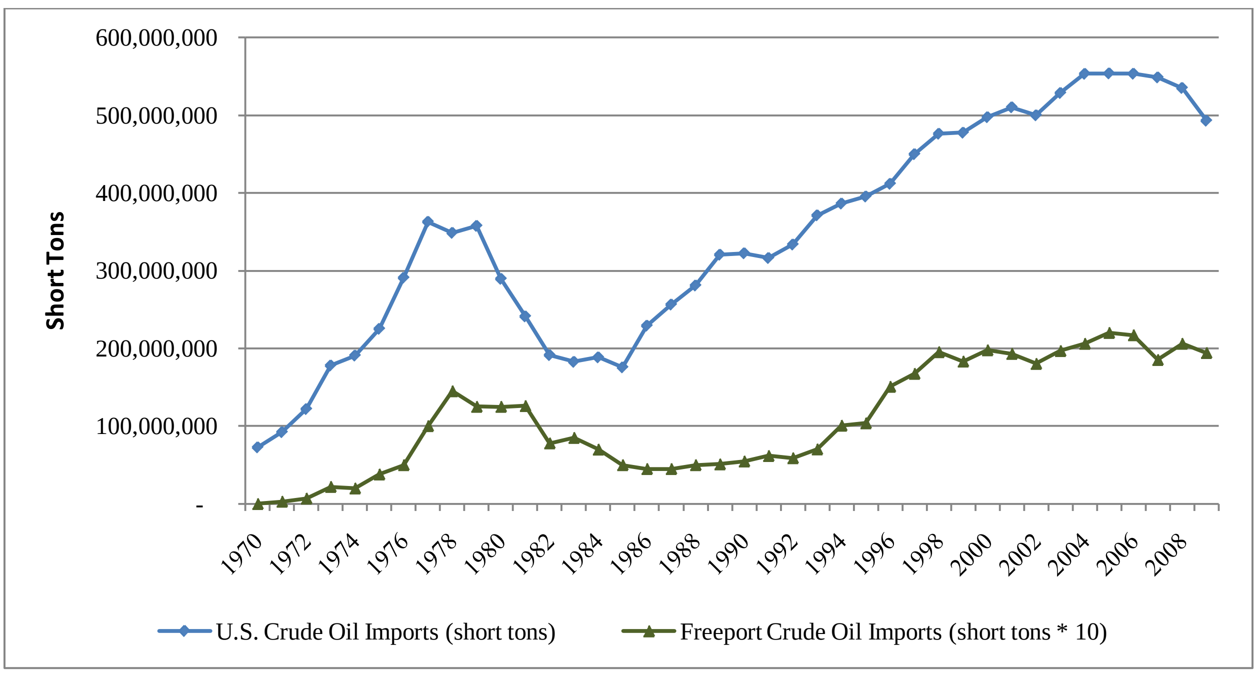
Figure 2-1 presents 1990 to 2009 Freeport, PADD III, and U.S. statistics and again helps to illustrate Freeport’s 1993 to 1998 relative increase in imports. Comparison of the Freeport and U.S. 1970 to 2009 longer-period relationship is illustrated in Figure 2-2.

Figure 2-1
U.S. PAD III and Freeport Crude Petroleum Imports (1990–2009)



Source: USACE, Waterborne Commerce of the U.S., Part 2, 1990–2009, and EIA.

Figure 2-2
U.S. and Freeport Crude Petroleum Imports (1970–2009)



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

Freeport's growth rates for crude petroleum imports exceed several other regional ports. Table 2-7 shows a comparison of annual growth rate data for Freeport and other Texas ports. Freeport's imports are expected to 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.

Table 2-7
Texas Port and U.S. Crude Petroleum Waterborne Imports (1993–2007)
(1,000s of short tons)

Year	Freeport	Texas City	Houston	Sabine-Neches Waterway	Corpus Christi	Total	U.S. Total
1993	7,025	33,111	27,952	32,639	18,395	119,122	371,267
1994	10,073	22,863	30,812	37,226	29,756	130,730	387,335
1995	10,378	27,781	22,392	38,743	27,183	126,477	371,415
1996	15,074	31,901	34,636	40,930	36,737	159,278	401,694
1997	16,742	33,900	46,516	51,142	41,627	189,927	429,301
1998	19,527	27,958	43,446	53,877	39,886	184,694	433,427
1999	18,321	26,900	37,472	53,834	36,029	172,556	439,806
2000	19,770	34,646	53,339	67,187	35,840	210,782	521,619
2001	19,307	38,688	46,755	64,226	32,226	201,202	486,249
2002	18,019	32,864	45,686	66,383	28,534	191,486	479,318
2003	19,672	38,773	52,623	70,158	32,516	213,742	515,747
2004	20,602	42,845	55,940	69,875	30,140	219,402	531,598
2005	22,000	35,644	58,037	59,691	30,514	205,886	522,784
2006	21,706	30,431	58,452	57,616	30,068	198,273	524,668
2007	18,523	32,620	54,112	56,171	33,520	194,946	521,948
1995–1997 Avg.	14,065	31,194	34,515	43,605	35,182	158,561	400,803
2005–2007 Avg.	20,743	32,898	56,867	57,826	31,367	199,702	540,361
Average Annual Growth Rate (%)	4.0	0.5	5.1	2.9	–1.1	2.3	2.7

Source: USACE, Waterborne Commerce of the U.S., Part 2, 1970–2007.

2.2 PETROLEUM AND CHEMICAL PRODUCT TRAFFIC

Regional production includes petroleum products and chemical products. Petroleum products include transportation fuels such as gasoline, diesel fuel, and jet fuel. Chemical products include sodium hydroxide, complex hydrocarbons, and ammonia. 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. For 2004 to 2006, petroleum and chemical imports and exports totaled 5.3 million short tons.

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. Table 2-8 shows Freeport's 1992 to 2007 percent of the U.S. totals. 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.

Table 2-8
Freeport Harbor
Petroleum and Chemical Product Imports and Exports
Percentages of U.S. Totals

	Petroleum Products		Chemical Products	
	Freeport Percentage of the U.S. Total		Freeport Percentage of the U.S. Total	
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.

Table 2-9 and Table 2-10 show Freeport's petroleum product imports and exports by major commodity group. Table 2-11 shows Freeport imports 14 percent of U.S. chemical hydrocarbons and 7.4 percent of ammonia. Chemical imports averaged 768 thousand short tons for 2003 to 2005 and 710 thousand short tons in 2007, which is less than one-third of exports. Freeport exports 32.8 percent of U.S. sodium hydroxide, 8.5 percent of U.S. organic chemicals, 8.8 percent of U.S. chemical hydrocarbon, and 7.3 percent of alcohols. Table 2-12 presents Freeport's chemical exports.

Table 2-9
Freeport Petroleum Products Imports by Major Commodity Group
Comparison with U.S. Petroleum Product Totals
(1,000s of short tons)

Major Group	Freeport Petroleum Product Imports										
	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Gasoline	–	–	–	5	26	–	222	1,395	960	733	623
Naphtha & solvents	149	157	74	547	833	323	417	351	180	175	125
Distillate fuel oil	52	5	67	–	–	–	–	140	102	3	–
Residual fuel oil	109	–	–	212	–	2	–	–	117	–	55
Lube oil	1,275	1,174	1,329	1,290	1,379	323	1,168	862	–	58	0
Hydrocarbons, Petroleum Gases & Other	161	485	169	–	175	23	50	123	337	111	242
Other	117	1,833	5	–	–	65	–	2	83	–	1
Freeport Petroleum Imports	1,863	3,654	1,644	2,054	2,413	736	1,857	2,873	1,779	1,080	1,046

Major Group	U.S. Petroleum Product Imports[a]										Freeport 2004–2006 % of U.S.
	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	
Gasoline	19,374	17,381	18,404	24,157	27,732	29,282	32,294	50,746	63,022	64,261	1.7
Kerosene	4,977	6,134	6,736	7,320	7,059	5,002	4,189	1,569	1,555	1,847	–
Naphtha & solvents	13,825	13,592	15,278	17,844	15,718	16,227	17,405	7,994	8,634	7,109	3.0
Distillate fuel oil	16,619	23,291	25,781	21,111	20,589	19,936	29,115	53,876	52,679	53,670	0.2
Residual fuel oil	29,198	35,327	35,229	40,361	40,891	35,411	31,330	13,955	13,757	9,723	0.3
Lube oil	11,144	12,736	10,901	9,040	10,353	8,606	10,653	10,148	6,393	666	5.3
Petroleum Coke	4,020	4,163	4,244	2,926	3,180	7,354	4,608	5,170	5,262	4,950	–
Other (primarily Naphtha and Solvents)	5,010	6,042	7,476	7,273	8,785	8,152	16,198	22,792	17,055	19,184	1.2
U.S. Petroleum Imports	104,167	118,666	124,049	130,032	134,307	129,970	145,792	166,250	162,479	161,410	1.2

Source: USACE, Waterborne Commerce of the U.S., Part 2, 1997–2007.

[a]Commodity-specific data for 2007 U.S. tonnage were not compiled for this presentation. U.S. imports totaled 161,160 thousand short tons.

Table 2-10
Freeport Petroleum Products Exports by Major Commodity Group
Comparison with U.S. Petroleum Product Totals (1,000s of short tons)

Major Group	Freeport Petroleum Product Exports										
	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Distillate fuel oil	72	22	19	0	0	1	3	66	15	50	20
Residual fuel oil	0	0	0	2	0	13	0	1	0	0	0
Lube oil & greases	10	14	14	18	16	0	8	2	3	4	3
Gasoline	33	4	5	20	13	98	67	20	67	50	58
Other	2	5	1	6	5	7	9	2	6	5	9
Freeport Petroleum Exports	117	45	39	46	34	119	87	91	91	109	90

Major Group	U.S. Petroleum Product Exports[a]										Freeport 2004–2006 % of U.S.
	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	
Distillate fuel oil	5,879	4,591	4,148	4,953	4,982	5,861	7,046	16,202	15,642	26,249	0.23
Residual fuel oil	8,519	9,282	10,030	12,693	14,032	12,129	9,420	1,269	3,501	2,538	0.01
Lube oil & greases	1,662	1,410	1,583	1,595	1,191	1,302	1,240	263	287	829	0.65
Gasoline	5,786	4,828	4,140	6,434	6,906	6,726	6,630	11,053	9,564	10,661	0.44
Other											
Liquid Natural Gas	2,170	2,144	2,197	2,842	2,150	2,757	2,327	2,251	1,889	2,441	–
Petroleum coke	21,239	19,298	17,926	23,508	23,859	26,520	26,904	30,588	28,676	30,202	–
Naphtha & Solvents	3,473	3,877	4,263	1,896	2,598	2,180	2,146	1,577	2,426	2,285	–
Kerosene	1,642	893	994	1,497	1,078	1,075	767	55	615	546	–
Asphalt, Tar & Pitch	3,960	3,340	2,693	58	32	81	365	291	279	474	–
Other	115	77	78	157	120	90	106	115	80	113	–
U.S. Total Petroleum Exports	54,445	49,740	48,052	55,633	56,948	58,721	56,951	63,664	62,959	76,338	0.13

Source: USACE, Waterborne Commerce of the U.S., Part 2, 1997–2007.

[a]Commodity-specific data for 2007 U.S. tonnage was not compiled for this presentation. U.S. exports totaled 82,317 thousand short tons.

Table 2-11
Freeport Chemical Products Imports by Major Commodity Group
Comparison with U.S. Chemical Product Totals
(1,000s of short tons)

Major Group	Freeport Chemical Product Imports										
	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Benzene & Toluene	7	61	65	100	82	136	75	26	27	34	63
Other Hydrocarbons	58	53	108	40	84	46	99	150	102	97	71
Alcohols	90	33	9	23	2	3	42	54	21	0	1
Carboxylic Acids	27	11	11	1	0	1	4	0	0	0	0
Organic Compounds	16	6	6	4	0	0	2	10	3	9	0
Ammonia	105	77	138	172	414	444	529	592	515	480	546
Sodium Hydroxide	6	7	0	0	0	1	0	0	5	0	12
Other (Inorganic Compounds, Nitrogen, and Paints)	24	7	4	56	1	31	27	3	18	94	17
Freeport Chemical Imports	333	255	341	379	583	663	778	835	691	705	710

Major Group	U.S. Chemical Product Imports[a]										Freeport 2004–2006 % of U.S.
	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	
Benzene & Toluene	292	513	584	1,603	1,260	1,224	1,378	1,883	1,874	2,473	1.4
Other Hydrocarbons	870	540	489	851	714	748	797	767	829	883	14.1
Alcohols	3,587	3,806	4,626	5,794	7,091	6,950	6,236	7,218	8,348	10,653	0.3
Carboxylic Acids	669	703	736	807	859	839	904	994	1,066	1,090	–
Organic Compounds	4,049	4,733	4,742	4,882	4,965	4,300	2,099	2,438	1,143	1,087	0.3
Ammonia	3,381	3,517	3,811	4,284	5,974	5,396	6,630	6,809	7,433	7,083	7.4
Sodium Hydroxide	599	731	591	899	940	877	874	931	1,215	1,494	–
Plastics	1,694	1,776	2,074	2,227	2,034	2,282	2,626	2,054	3,646	3,850	–
Fertilizers	4,280	5,062	4,317	7,827	11,274	6,134	8,577	7,527	8,894	7,875	–
Inorganic Elem., Oxides & Halogen Salts	766	838	1,051	2,153	1,305	3,046	2,288	2,981	2,134	2,625	–
Other	4,867	5,224	5,120	7,150	7,417	7,776	9,598	10,208	8,835	8,900	–
U.S. Total Chemical Imports	25,054	27,443	28,141	38,477	43,833	39,572	42,007	43,810	45,417	48,013	1.6

Source: USACE, Waterborne Commerce of the U.S., Part 2, 1997–2007.

[a]Commodity-specific data for 2007 U.S. tonnage was not compiled for this presentation.
U.S. imports totaled 82,317 thousand short tons.

Table 2-12
Freeport Chemical Products Exports by Major Commodity Group
Comparison with U.S. Chemical Product Totals (1,000s of short tons)

Major Group	Freeport Chemical Product Exports										
	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Benzene & Toluene	0	0	0	0	0	1	0	9	1	0	2
Other Hydrocarbons	240	380	409	546	385	350	578	486	478	383	460
Alcohols	12	31	57	96	137	112	148	241	159	174	200
Carboxylic Acids	66	23	5	3	14	69	22	91	24	35	35
Organic Compounds	162	166	160	232	216	231	211	268	189	318	218
Sodium Hydroxide	788	820	752	1,043	836	817	874	1,162	1,318	1,280	1,304
Plastics	205	258	209	197	282	273	257	273	262	289	337
Other	49	46	40	100	78	54	14	92	78	72	135
Freeport Chemical Exports	1,522	1,724	1,632	2,217	1,948	1,907	2,104	2,622	2,509	2,551	2,691

Major Group	U.S. Chemical Product Exports[a]										Freeport 2004–2006 % of U.S.
	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	
Benzene & Toluene	325	162	66	225	649	151	545	847	670	397	0.5
Other Hydrocarbons	4,471	4,554	5,525	6,188	4,457	5,116	5,821	6,144	4,867	4,328	8.8
Alcohols	2,814	2,143	2,090	2,649	2,617	2,604	2,726	2,763	2,261	2,828	7.3
Carboxylic Acids	2,216	2,102	1,912	2,541	2,640	3,030	2,700	2,782	2,464	2,886	1.8
Organic Compounds	1,361	2,019	1,905	2,226	2,233	2,454	2,201	2,342	2,597	4,182	8.5
Ammonia	577	821	777	716	825	577	482	532	649	187	–
Sodium Hydroxide	2,950	3,102	3,219	4,384	3,379	3,631	3,422	3,892	3,795	3,776	32.8
Plastics	6,046	5,774	5,376	6,883	6,568	6,268	5,971	7,868	7,255	7,767	3.6
Fertilizers	16,030	17,818	18,956	13,536	13,577	13,246	12,878	13,411	12,983	12,165	–
Metallic Salts	4,908	4,468	4,221	5,751	5,389	5,204	5,195	5,926	5,431	5,457	–
Inorganic Elem., Oxides & Halogen Salts	1,136	1,158	993	3,322	2,959	3,301	2,518	4,369	4,486	5,325	–
Nitrogen	1,711	1,538	1,619	2,174	2,431	2,132	2,201	2,342	1,944	2,096	–
Other	5,992	5,688	5,540	7,293	7,017	7,248	6,915	7,516	7,282	7,275	–
U.S. Total Chemical Exports	50,537	51,345	52,199	57,888	54,741	54,962	53,575	60,734	56,684	58,669	4.4

Source: USACE, Waterborne Commerce of the U.S., Part 2, 1997–2007.

[a]Commodity-specific data for 2007 U.S. tonnage was not compiled for this presentation.
U.S. exports totaled 60,168 thousand short tons.

2.3 GENERAL AND CONTAINER CARGO TRAFFIC

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.[3] 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 onto shop floors. Flat rack containers make a bed for outsized items such as yachts and heavy industrial machinery.

Since Freeport's container terminal is new, the Port of Houston was analyzed for historical traffic data. U.S. and Houston 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). Figure 2-3 displays percentage distributions of U.S. and Houston imports and manufacturing goods (17 percent); food and farm products (22 percent) and other (5 exports by major group).

Container traffic is generally grouped as either local or intermodal. Local cargo can be delivered by truck within one day. Intermodal is generally rail bound for more-distant locations. Information shown in the Center for Transportation Research's 2007 study indicates that over 90 percent of Houston container cargo is transported through the port by truck.[4]

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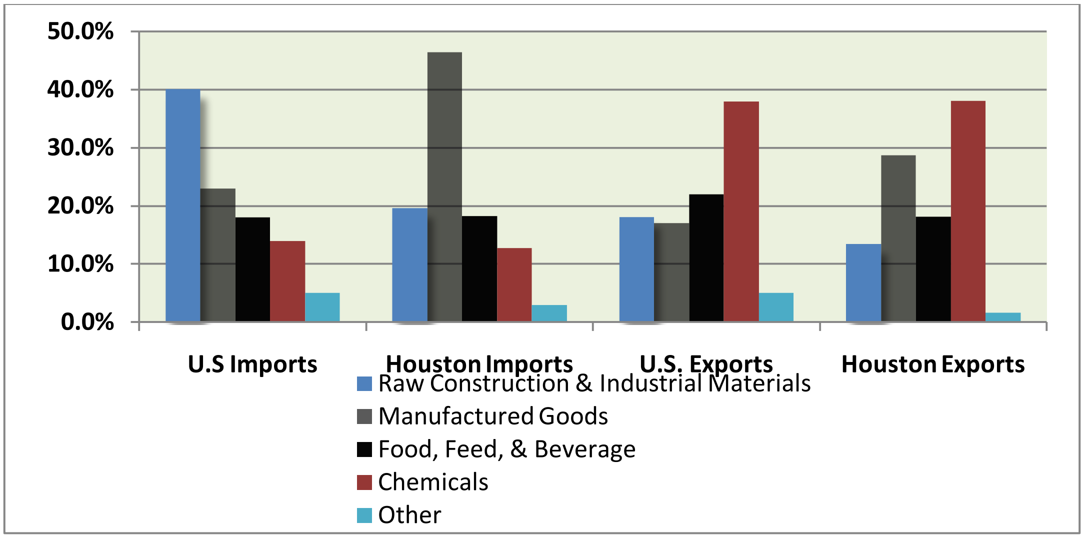
[3] Seafarer, *The Rise of the Supership*, Summer 2005, p. 12

[4] University of Texas Center for Transportation Research, *Planning for Container Growth along the Houston Ship Channel and Other Texas Seaports*, November 2006 revised February 2007, p. 15.

Figure 2-3
U.S. and Houston Container Cargo (2006–2007 Period)
Percentage of Imports and Exports by Major Commodity Group



Source: USACE, NDC.

Comparison of regional and national container TEU volumes for 1980 to 2008 is summarized in Table 2-13. The term TEU refers to Twenty Foot-Equivalent Units or equivalent capacity of one 20-foot container. A 40-foot container is two TEUs. Figures 2-4 and 2-5 provide comparisons of U.S. West Coast, East Coast, and Gulf Coast 1999 to 2008 container throughputs. The figures show that the Gulf Coast traffic increased relative to the West and East coasts.

While U.S. container growth continued through 2007, fourth-quarter 2007 volumes were relatively flat due to weakening of the dollar in relation to other currencies. A weakening dollar contributes to a downturn in imports and an increase in exports. Freeport's throughput increased through 2007.

The USACE 2007 Waterborne Commerce statistics show an approximate 50/50 split between Houston's imports and exports. In classifying the markets served by Houston in comparison to the U.S. West and East coasts, the U.S. West Coast ports of Los Angeles and Long Beach primarily process imports from the Far East. The U.S. East Coast ports, particularly Newark and New York, process a high volume of European imports and, to a smaller extent, Far East traffic. Table 2-14 displays the 2007 estimated distribution of imports and exports by major U.S. container port.

Table 2-13
U.S. Container Cargo by Region (TEUs including empties)

Year	Freeport	Houston	Texas	U.S. Gulf	U.S. Pacific	U.S. Atlantic	U.S. Total
1980	0.0	300.4	300.4	579.9	3,511.9	4,348.0	8,439.9
1981	0.0	318.7	361.2	564.6	2,595.6	4,485.5	7,645.7
1982	0.0	306.1	387.5	692.8	3,435.8	4,299.0	8,427.6
1983	0.0	303.5	378.3	670.0	3,045.5	4,651.1	8,366.7
1984	17.4	372.3	439.4	831.2	5,384.9	5,554.5	11,770.6
1985	19.4	362.7	402.1	812.1	5,398.8	5,513.3	11,724.2
1986	38.8	403.0	484.4	928.3	5,997.6	5,805.8	12,731.8
1987	36.7	484.6	578.6	911.2	6,568.6	5,776.4	13,256.2
1988	37.2	530.6	625.4	895.1	6,993.9	6,250.7	14,139.7
1989	27.9	498.8	593.7	813.8	7,824.2	6,432.1	15,070.1
1990	29.9	502.0	583.1	822.4	8,185.4	6,564.1	15,571.9
1991	24.0	535.1	652.8	937.5	8,376.9	7,001.8	16,316.2
1992	29.7	490.1	640.0	1,141.7	8,961.3	7,212.3	17,315.3
1993	30.5	538.7	672.8	1,191.2	9,253.6	8,254.0	18,698.8
1994	34.1	578.7	696.9	1,222.3	10,458.9	8,807.2	20,488.4
1995	30.5	704.0	774.9	1,186.5	11,421.9	9,728.9	22,337.3
1996	48.2	797.7	856.5	1,361.8	11,202.6	10,046.2	22,610.6
1997	45.1	933.5	993.8	1,491.9	12,086.7	10,945.6	24,524.1
1998	54.7	959.1	1,028.3	1,470.1	13,208.9	11,486.6	26,165.7
1999	63.4	1,031.1	1,164.7	1,618.6	14,085.0	12,303.7	28,007.3
2000	71.5	1,061.5	1,217.3	1,687.6	15,665.7	13,042.5	30,395.8
2001	74.3	1,057.9	1,216.0	1,703.1	15,951.5	13,009.2	30,663.8
2002	74.5	1,147.5	1,265.5	1,717.9	17,363.5	13,621.4	32,702.9
2003	67.8	1,243.9	1,321.6	1,838.0	20,060.4	14,401.7	36,300.0
2004	68.6	1,437.6	1,516.4	2,068.7	21,179.6	15,406.4	38,654.7
2005	76.3	1,594.4	1,678.0	2,174.4	23,010.8	16,783.2	41,968.4
2006	73.6	1,606.4	1,690.7	2,238.7	24,682.9	17,446.6	44,368.2
2007	75.7	1,768.6	1,853.7	2,531.5	24,533.9	17,942.6	45,008.0
2008	71.9	1,794.3	1,878.3	2,544.9	22,597.6	17,685.1	42,827.6
% Average Annual Growth Rate 1983/1985 to 2006/2008	6.1	6.8	6.2	4.8	6.2	4.9	5.5

Source: Compiled from American Association of Port Authorities website, November 2007.

Figure 2-4
U.S. East Coast and West Coast Container Cargo (TEUs)
Billions of Chained 2000 Dollars (1999–2008)

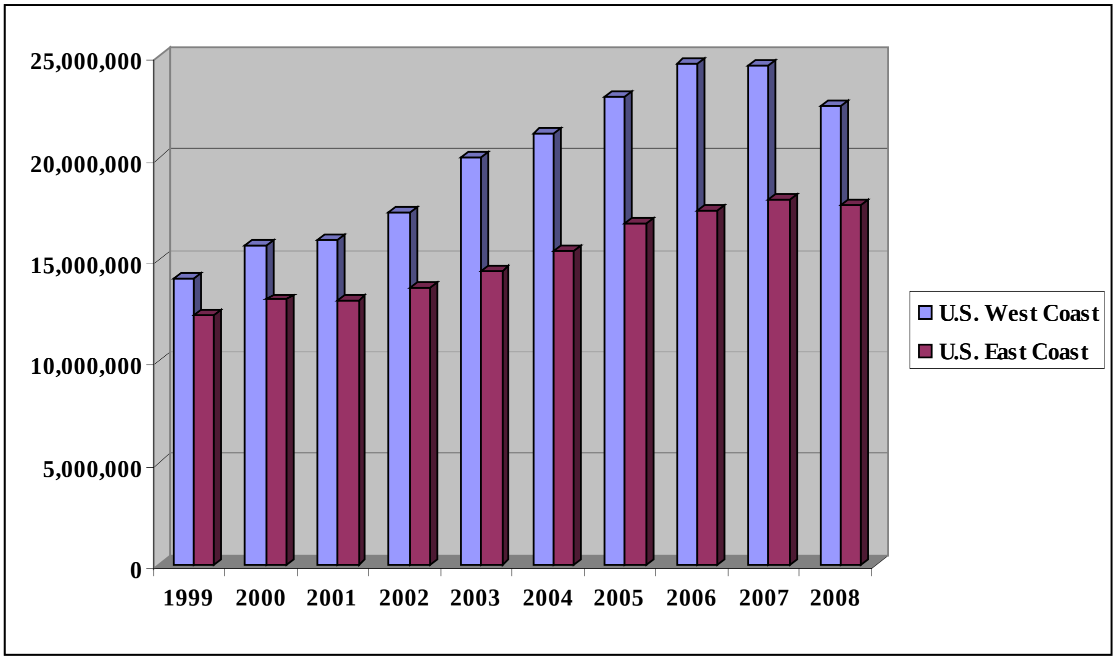


Figure 2-5
U.S. Gulf Coast Container Cargo (TEUs)
Billions of Chained 2000 Dollars (1999–2008)

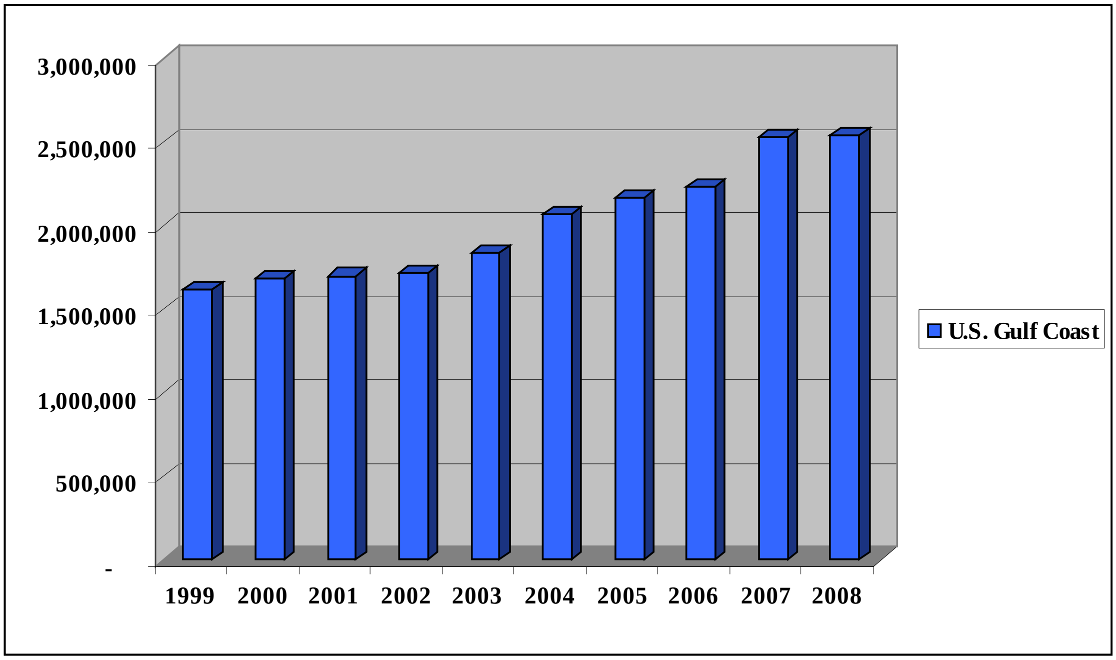


Table 2-14
U.S. Waterborne Container Traffic by Port/Waterway
(% of Loaded and Empty TEUs[a])

Port	Inbound	Outbound	Total
Long Beach	78	22	100
Los Angeles	79	21	100
New York (NY & NJ)	73	27	100
Oakland	62	38	100
Tacoma	75	25	100
Charleston	60	40	100
Savannah	54	46	100
Seattle	70	30	100
Norfolk Harbor	62	38	100
Houston	53	47	100
All Other	75	25	100
U.S. Total	72	28	100

Source: USACE, NDC Website data, CY 2007.

[a]TEU = 20-foot equivalent units. Foreign empties not included.

Declines in growth seen on the West Coast and to a lesser extent on the East Coast, and relatively flat rates on the U.S. Gulf Coast are attributable to falling home prices, lower employment growth, tighter credit, high oil prices, and the declining value of the dollar in the world market. While having a negative effect on investment and other general indicators, the decline in interest rates has improved the competitiveness of U.S. producers and contributed to recent increases in exports.

Another factor that influences trade is regional population growth. Table 2-15 displays regional population data obtained from the U.S. Census.

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 2-16 and Figure 2-6. Freeport imports 6 percent of the U.S. banana imports and exports 6 percent of U.S. rice exports. Bananas and rice are transported through docks located within the Brazos Turning Basin.

Rock and limestone are used in residential and commercial building construction and have increased at all Texas ports. These cargoes are presently transported through the facilities in the Brazos Harbor Basin. Limestone imports represented 40 percent of 2003 to 2005 general cargo tonnage. Total limestone imports for 2005 were 433,000 tons. The majority of imports are from Cozumel, Mexico, and, to a smaller extent, Europe.

Table 2-15
Houston-Galveston-Brazoria Consolidated Metropolitan Statistical Area
2000–2008 Population Estimates, Select Communities

County	2000	2008	2000–2008 Actual Growth Rate (%)	2000–2010 Anticipated Growth Rate (%)[a]
Brazoria County	241,767	301,004	2.8	1.9
Harris County	3,321,660	3,984,349	2.3	1.7
Fort Bend	354,452	532,141	5.2	3.7
Wharton County	41,188	40,791	–0.1	0.6
Galveston	250,158	288,239	1.8	0.8
Matagorda	37,957	37,265	–0.2	0.7
Total	4,247,182	5,183,789	2.5	1.8

Source: U.S. Bureau of Census, State and County Quick Facts, 2009.

[a]Texas Water Development Board, 2006 Regional Water Plan, County Population Projections.

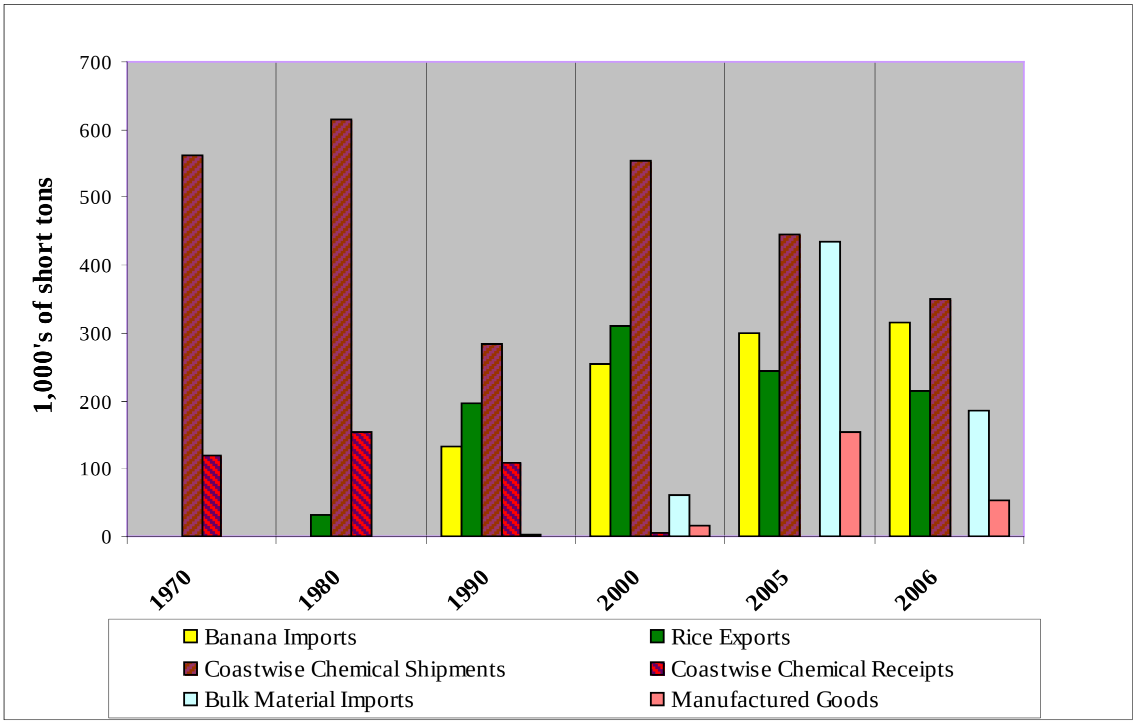
Table 2-16
Freeport Harbor Other Ocean-going Cargo
Major Commodities 1970–2007
(1,000s of short tons)

Year	Banana Imports	Rice Exports	Bulk Materials & Manufactured Goods	Coastwise Chemicals		Group Total	Total Ocean-going Tonnage	% of Total Ocean-going Tonnage
				Receipts	Shipments[a]			
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.

[a]Primarily consist of shipments of hydrocarbons.

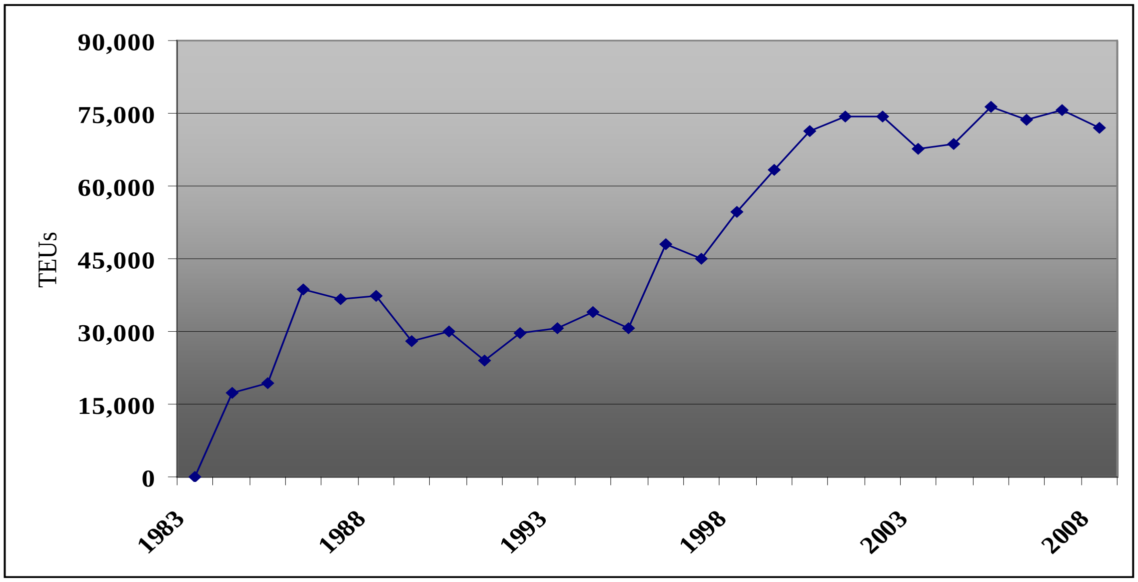
Figure 2-6
Freeport Harbor 1970–2006
Other Ocean-going Cargo
(1,000s of Short Tons)



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

For 2008, the port throughput totaled 72,000 TEUs, in part as a result of containerization of some cargo that previously moved in palletized form. With the acquisition of a mobile harbor crane, the port unloads a greater percentage of containers as opposed to relying on shipboard cranes. Figure 2-7 displays Freeport’s 1983 to 2008 container cargo totals.

Figure 2-7
Freeport Channel Container Cargo 1983–2008 (TEUs)

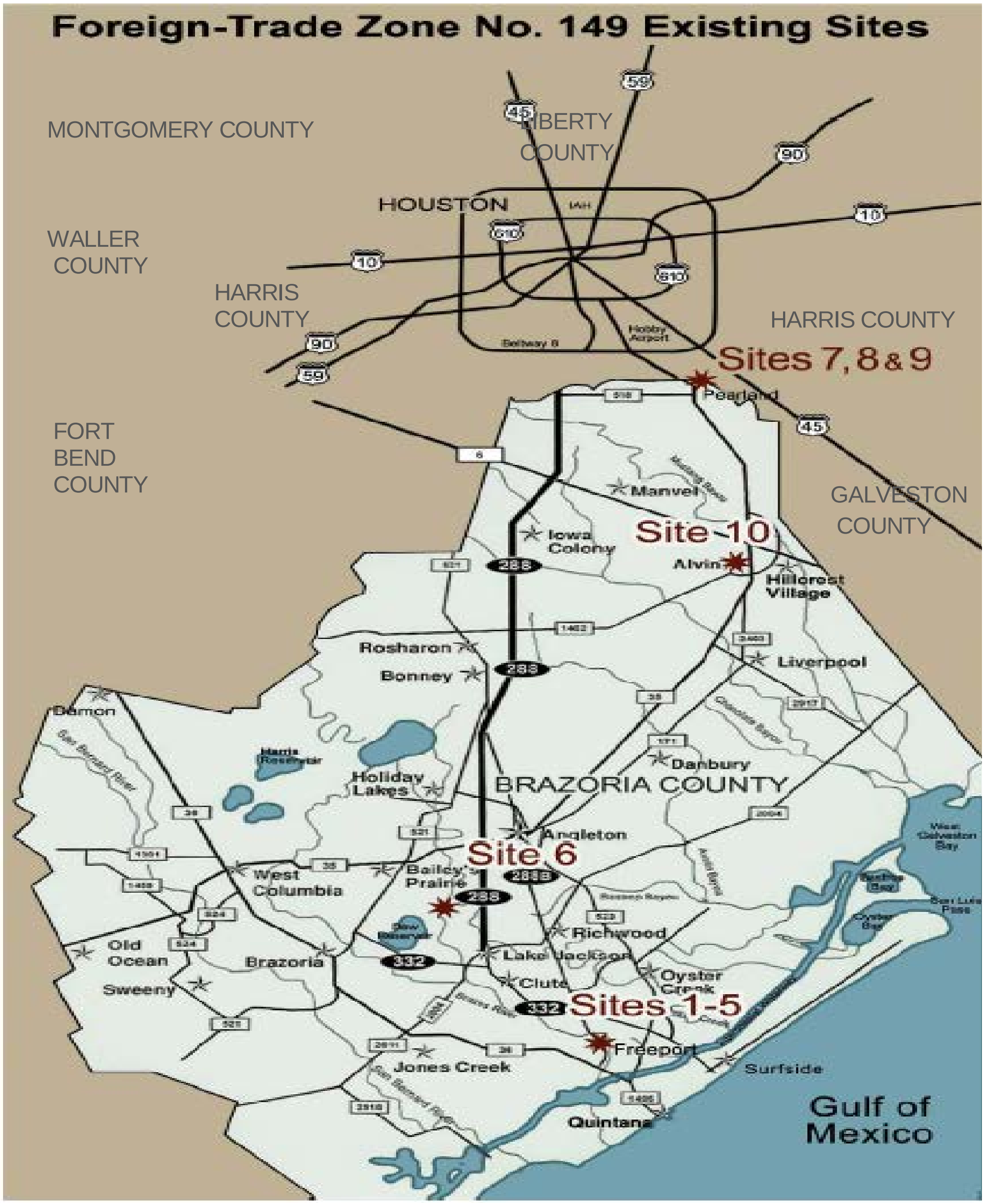


Source: Compiled from American Association of Port Authorities website, May 2009.

The Port of Freeport is contained in a relatively large foreign trade zone (FTZ No. 149). 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.

In March 2010 the U.S. Department of Commerce approved the application for expansion of the Port Freeport FTZ to include two new sites in adjacent Fort Bend County. The addition of the Fort Bend sites results in a total of 12 sites. Sites 11 and 12 are located south of Interstate 10 and adjacent to SH 59. Site 11 is 311 acres being developed by GBI Group LLC. Site 12 is approximately 636 acres being developed by KCSR and CenterPoint Intermodal Center. Both sites are adjacent to the KCSR track. Figure 2-8 displays the FTZ within the port and Brazoria County as of 2009.

Figure 2-8
Port Freeport Foreign Trade Zone No. 149 Sites as of 2009



2.4 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 the USACE. The types of vessels mooring in the Upper Stauffer Channel 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 the USACE NDC and subsequent discussion with NDC personnel, the Galveston District concluded that vessel activities not associated with cargo discharge frequently go unreported. To get a more accurate estimate of traffic, 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. Also, the District contacted industry and 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. In comparison, the NDC entrance and clearance records showed nearly 100 vessels per month for Galveston and nearly 200 for Bayou Lafourche, indicating that offshore vessels at Freeport are underreported.

The OSVs using the channel are generally based in Louisiana. The OSV fleet, which includes U.S. and foreign-flagged vessels, consists of crewboats, platform supply vessels, and anchor tugs and comes 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.[5] 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

[5] Hornbeck Oil Services, webpage information

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 *Code of Federal Regulations* (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.

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. Table 2-17 displays the world OSV fleet by vessel type major classification.

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 in the 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.

Table 2-17
Offshore Supply Vessels
World Fleet, Active Vessels, and Vessels on Order

Year Built	Anchor-Handling Tug Supply Vessel	Crew Supply Vessel	Tug Supply Vessel	Pipe Carrier	Platform Supply Vessel	Grand Total
Number of Vessels						
1974 to 1978	127	41	133	18	194	513
1979 to 1983	267	97	144	21	453	982
1984 to 1988	144	60	46	30	92	372
1989 to 1993	28	83	14	18	39	182
1994 to 1998	45	78	20	3	112	258
1999 to 2003	154	140	30	2	260	586
2004 to 2008	466	190	76	1	421	1,154
2009 to 2012	427	38	34	–	226	725
Total	1,658	727	497	93	1,797	4,772
Percentage of Vessels						
1974 to 1978	7.7	5.6	26.8	19.4	10.8	10.8
1979 to 1983	16.1	13.3	29.0	22.6	25.2	20.6
1984 t o 1988	8.7	8.3	9.3	32.3	5.1	7.8
1989 to 1993	1.7	11.4	2.8	19.4	2.2	3.8
1994 to 1998	2.7	10.7	4.0	3.2	6.2	5.4
1999 to 2003	9.3	19.3	6.0	2.2	14.5	12.3
2004 to 2008	28.1	26.1	15.3	1.1	23.4	24.2
2009 to 2012	25.8	5.2	6.8	0.0	12.6	15.2
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: Lloyd's Register – Fairplay, PC Register of Ships, November 2008.

2.5 LIQUEFIED NATURAL GAS TRAFFIC

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 and claims no benefits from LNG.

2.6 EXISTING OPERATING CONSTRAINTS

Freeport's existing traffic, particularly crude petroleum tankers and product tankers, are subject to vessel size limitations due to the existing 400-foot channel width. The maximum ship dimensions permitted by the Brazos River Pilots Association (BRPA), without waiver, are 820-foot length overall (LOA) and 145-foot maximum beam, as shown in Table 2-18. Vessel length limitations are enforced because crosswinds and crosscurrents force tankers to "crab" at an angle though the entranced 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 exacerbate traffic delays. Based on BRPA 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 the Engineer Research and Development Center (ERDC) found that a channel width of 600 feet would be necessary to accommodate the 264,000-cubic-meter (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 longshore 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.

Table 2-18
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.
4.	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.

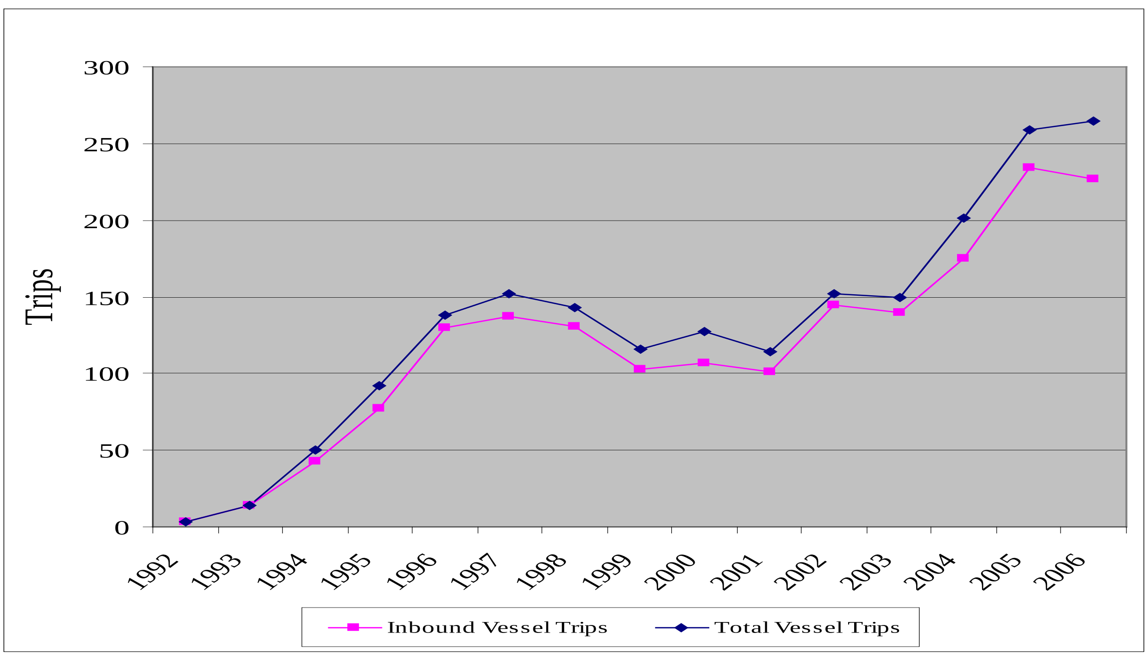
Source: http://www.brazospilots.com/operatingprocedures.html

3.0 HISTORIC VESSEL UTILIZATION PATTERNS

This section discusses vessel utilization patterns before and after the 45-foot Project depth became available in the mid-1980s. Figure 3-1 shows that Freeport experienced an overall increase in the number of vessels associated with loaded drafts over 38 feet from the years 1992 to 2006.

Table 3-1 presents 1992 to 2006 inbound vessels by loaded draft. 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.

Figure 3-1
Vessel Trips for Vessels with
Loaded Drafts Over 38 Feet
(1992–2006)



Source: USACE, Waterborne Commerce of the U S., Part 2, 1992–2006.

Table 3-1
Freeport Harbor
Estimated Vessel Movements by Loaded Draft (1992–2006),
Number of Vessel Movements (Self-Propelled Vessels), and Total Vessel Tonnage

Year	Vessel Movements by Loaded Draft (feet)							Short Tons (1,000s) Total Tonnage
	<18	19–24	25–29	30–35	36–38	>38	Total	
1992	1,456	321	352	195	133	3	2,460	9,753
1993	2,956	369	298	170	76	14	3,883	9,739
1994	2,057	346	352	165	98	50	3,068	13,450
1995	5,617	369	288	178	112	92	6,656	14,922
1996	3,692	274	423	196	121	138	4,844	19,880
1997	2,729	254	479	249	127	152	3,990	21,849
1998	2,587	312	594	249	157	143	4,042	24,552
1999	1,530	311	434	216	172	116	2,779	23,225
2000	2,749	357	557	222	154	127	4,166	26,150
2001	4,293	233	554	223	210	114	5,627	25,498
2002	438	213	626	320	138	152	1,887	22,563
2003	397	199	796	312	137	150	1,991	25,612
2004	413	170	787	378	152	201	2,101	29,116
2005	175	125	782	309	122	259	1,772	28,930
2006	163	191	705	250	116	265	1,690	27,571

Source: USACE, Waterborne Commerce of the U.S., Part 2, 1992–2006.

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 is 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. Table 3-2 shows inbound and outbound trips for loaded drafts over 38 feet.

Table 3-2
Freeport Harbor Number of Vessels for Loaded Drafts Over 38 Feet
Inbound and Outbound Vessel Movements (1992–2006)

Year	Inbound Vessels by Loaded Draft (feet)							% Deep-Draft Vessels[a]
	39	40	41	42	43	44	Total	
1992	3	0	0	0	0	0	3	0.2
1993	8	3	0	2	1	0	14	0.7
1994	21	17	3	2	0	0	43	1.7
1995	36	23	12	6	0	0	77	2.3
1996	59	37	16	18	0	0	130	5.4
1997	52	63	9	12	1	0	137	6.9
1998	73	43	11	4	0	0	131	6.8
1999	54	26	10	10	3	0	103	7.5
2000	49	20	16	22	0	0	107	5.2
2001	30	19	11	41	0	0	101	3.5
2002	23	14	4	104	0	0	145	14.9
2003	39	26	21	54	0	0	140	13.6
2004	55	29	49	42	0	0	175	17.2
2005	47	136	8	43	0	0	234	26.7
2006	47	86	90	4	0	0	227	26.1
	Outbound Vessels by Loaded Draft (feet)[b]							
1992	0	0	0	0	0	0	0	0.0
1993	0	0	0	0	0	0	0	0.0
1994	4	3	0	0	0	0	7	0.3
1995	7	7	1	0	0	0	15	0.5
1996	6	2	0	0	0	0	8	0.3
1997	5	9	0	0	0	0	15	0.7
1998	6	4	0	2	0	0	12	0.6
1999	9	3	1	0	0	0	13	0.9
2000	7	11	1	1	0	0	20	1.0
2001	9	2	0	2	0	0	13	0.5
2002	3	1	2	1	0	0	7	0.7
2003	4	5	1	0	0	0	10	1.0
2004	18	8	0	0	0	0	26	2.4
2005	12	11	1	1	0	0	25	2.8
2006	15	19	1	1	0	2	38	4.5

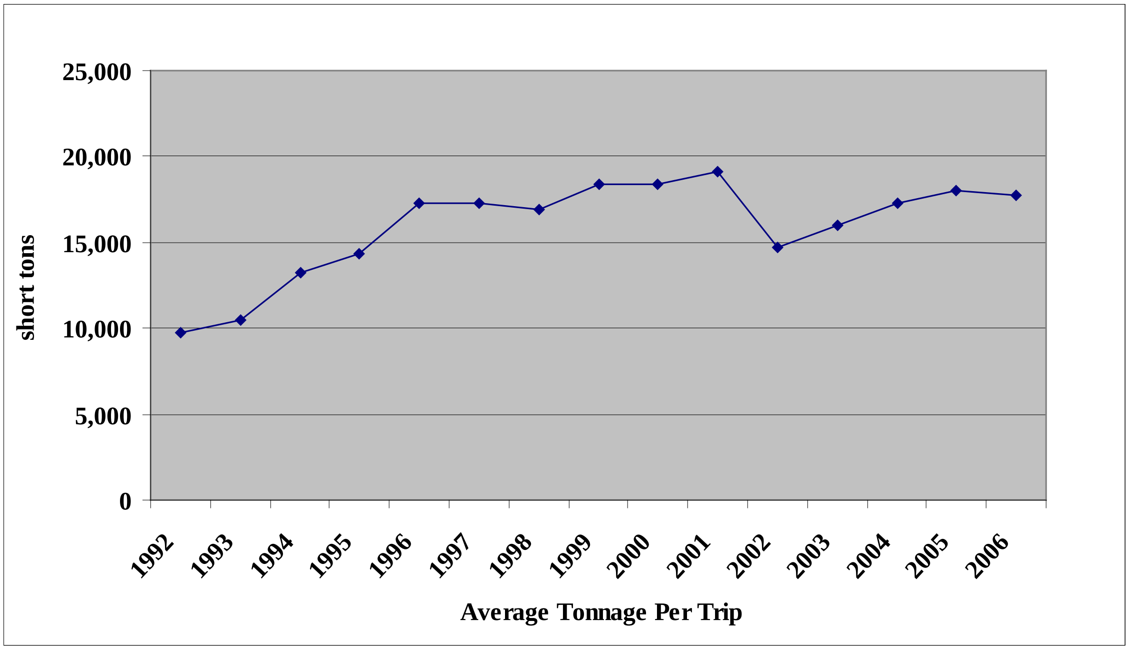
Source: USACE, Waterborne Commerce of the U.S., Part 2, 1992–2006.

[a]Percentage of loaded vessel drafts >=39 feet to all trips with loaded drafts greater than 18 feet.

[a]In 2006, there were 2 outbound vessels with loaded drafts of 45 feet. The next largest loaded draft group was 42 feet.

Freeport's vessel utilization data show a general increase in average tonnage per trip and suggests use of more fully loaded vessels. The increase in the volume of tonnage per trip is primarily associated with crude petroleum and petrochemical products, but other commodities are being transported in larger parcels as well. Figure 3-2 shows average tonnage per trip for ocean-going traffic, and it is based on vessels with loaded drafts over 18 feet and total ocean-going tonnage.

Figure 3-2
Freeport Channel
Average Tonnage Per Vessel Trip
(1992–2006)



Source: USACE, Waterborne Commerce of the U.S., Part 2, 1992–2006.

3.1 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 the BRPA said it is their understanding that since the grounding of the Exxon *Valdez* and OPRA 90, the U.S. Coast Guard (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. The transit data show this to be true.

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.

3.2 COMMODITY-SPECIFIC VESSEL UTILIZATION

This section presents analysis 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.

3.2.1 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 3-3 presents distributions of crude petroleum imports by vessel size for 1990, 1993 and 2003 to 2007. The period between 1993 and 2003 shows a clear distinction of transition to larger vessels. Table 3-4 displays representative vessel characteristics corresponding to Freeport’s current crude petroleum fleet.

Table 3-3
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 3-4
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.

Table 3-5 displays Freeport's 2005 to 2006 fleet of 115,000 to 159,500 DWT tankers. The first section of the table shows the 147,080 to 159,999 DWT vessels. Freeport's load patterns for the larger class of tankers showed the loaded drafts for 147,080 to 159,500 DWT tankers ranged from 30 to 40 feet. In 2005, thirteen vessels were in this range with the median loaded draft of 33 feet. In 2006, fifteen vessels were in this range with the median loaded draft of 37 feet. These vessels are most likely associated with lightening, the process where a fully loaded tanker sails from locations such as West Africa to the Gulf of Mexico. These vessels offload a partial load of cargo in order allow them to enter ports such as Freeport. The effect of an increase in channel depth at Freeport would allow these vessels to offload less cargo offshore.

Based on the current BRPA rules, vessels in the 145,000 to 150,000 DWT range require waivers. 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 ships per month are granted waivers.

Table 3-6 shows Freeport's 2005 to 2007 average crude oil imports by vessel class and associated vessel dimensions. Table 3-7 displays the distribution of Freeport's 1990, 1993, and 2000 to 2007 crude petroleum imports by loaded draft. The distribution of tonnage by loaded draft shows annual variations but illustrates greater concentration of loaded drafts of 40 feet or more in the years since 2000.

Table 3-5
Freeport Harbor's 2005–2006 Fleet of 115,000 to 159,500 DWT Tankers

Vessel Name	Loaded Draft (feet)	DWT	LOA (feet)	Beam (feet)	Design Draft (feet)	Year Built	Region of Origin	Current Shipping Method	Date of Entry (month, year, day)
Axel Spirit	40	115,392	820	144	49	2004	Venezuela	Direct	06520
Dubai Legend	39	112,661	820	144	48	2002	Venezuela	Direct	08617
Mare Tirrenum	40	110,729	805	138	48	2004	West Africa	Direct	06515
Avor	38	113,033	820	144	48	2003	Colombia	Direct	11627
Krymsk	37	115,605	820	144	49	2003	Bahamas	Direct	05619
Montigny	37	115,418	817	144	49	2003	Bahamas	Direct	02617
Helga Spirit	37	114,780	820	144	49	2005	Bahamas	Direct	06606
Atlantic Galaxy	34	115,583	817	144	48	2005	West Africa	Lightening	08629
Kazan	30	115,727	820	144	49	2003	Colombia	Lightened	12522
Sonangol Girassol	40	159,057	899	157	52	2000	West Africa	Lightening	04523
Sks Saluda	40	159,000	899	164	52	2003	West Africa	Lightening	12625
Astro Polaris	40	158,892	899	157	52	2004	West Africa	Lightening	03604
Sks Sira	39	159,453	899	158	56	2002	North Africa	Lightening	04614
Scf Altai	39	159,168	899	157	52	2001	West Africa	Lightening	10625
Nordic Hunter	36	151,401	899	158	53	1997	North Africa	Lightening	02524
Knock Dun	35	147,048	899	146	53	1994	West Africa	Lightening	03527
Pecos	33	157,400	899	151	56	1998	United Kingdom	Lightening	10524
Astro Phoenix	32	158,892	899	157	52	2004	North Africa	Lightening	06613
Kaspiy	32	150,812	883	151	57	1998	United Kingdom	Lightening	08513
Front Brabant	32	149,999	883	151	57	1998	West Africa	Lightening	12515
Sea Star	31	148,435	882	151	55	1996	West Africa	Lightening	05520
Sks Saluda	30	159,000	899	157	52	2003	North Africa	Lightening	09511

Source: USACE, NDC detailed unpublished data, 2005-2006.

Table 3-6
Freeport Crude Oil Imports 2005–2007
Total Tonnage and Representative Vessel Characteristics

DWT Range	Freeport Crude Oil % of Imports by DWT 2005–2007 Average	Median Dimensions			Design Draft (feet)			Year Built[a]
		DWT	Length (feet)	Beam (feet)	Median	Min.	Max	
<50,000	1.0	46,000	600	106	38	12	41	2004
50,000 to 69,000	2.4	65,275	724	106	44	40	46	2005
70,000 to 79,999	5.0	72,604	750	106	46	41	48	2005
80,000 to 84,999	0.5	84,999	784	125	43	43	48	2002
85,000 to 89,999	0.3	n/a	n/a	n/a	n/a	n/a	n/a	n/a
90,000 to 94,999	7.5	92,998	773	138	47	45	50	2003
95,000 to 99,999	27.4	99,850	805	138	47	44	49	2003
100,000 to 104,999	16.2	104,075	800	138	48	44	49	2005
105,000 to 109,999	28.1	105,994	800	138	49	40	51	2004
110,000 to 114,999	5.8	113,782	820	144	49	39	49	2005
115,000 to 119,999	1.1	115,572	817	144	49	48	51	2005
120,000 to 139,999	0.0	n/a	n/a	n/a	n/a	n/a	n/a	n/a
140,000 to 154,999	3.3	149,991	899	158	54	52	57	2004
155,000 to 159,999	0.5	159,117	899	157	56	52	56	2004
160,000 to 169,999	0.1	163,750	899	164	56	49	57	2005

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.
[a]Representative Year.

Table 3-7
Freeport Crude Petroleum Imports Percentage of Short Tons by Loaded Draft
1990, 1993, and 2000–2007

Loaded Draft (feet)	1990	1993	2000	2001	2002	2003	2004	2005	2006	2007
<=36	42.3	73.6	43.1	38.9	21.1	23.1	17.6	14.2	12.4	17.4
37	26.0	6.6	8.9	13.8	7.4	9.1	9.8	5.2	5.0	6.3
38	31.7	4.1	11.8	14.6	12.5	19.2	15.9	8.1	5.6	6.0
39	–	9.3	20.8	11.6	9.6	13.0	15.8	13.7	13.6	10.3
40	–	3.8	7.3	6.5	5.5	6.2	7.6	40.2	29.4	9.7
41	–	1.3	3.0	1.0	0.6	6.5	18.6	3.0	32.9	39.9
42	–	1.3	5.1	13.6	43.3	22.9	14.7	15.6	1.1	10.4
43	–	–	–	–	–	–	–	–	–	–
Total	100	100	100	100	100	100	100	100	100	100

Source: USACE, NDC detailed files.

The next series of tables provides data associated with crude petroleum imports by loaded draft and design draft. Table 3-8 displays a matrix of 2005 to 2007 average tonnage by loaded draft and design draft and shows that 96.8 percent of 2005 to 2007 tonnage is shipped in vessels with design drafts over 40 feet. Freeport's deep-draft vessel fleet statistics show that 80 percent of recent crude petroleum tonnage was transported in vessels with design drafts over 44 feet. Sixty-one percent of tonnage was loaded to 40 feet or greater. Table 3-9 displays trips by vessel DWT and loaded draft for 2004 to 2006.

Table 3-8
Crude Petroleum Short Tons 2005–2007 Average
by Design Draft and Loaded Draft
1,000s of Short Tons

Design Draft (feet)	Loaded Draft (feet)								Total %
	25–29	30–34	35–37	38–39	40	41	42	Total	
<30								–	
34–36		11.7						11.7	0.1
37–39	13.7	10.0						23.7	0.1
40	22.3	47.7	109.7	181.7	176.3	56.7	–	594.3	3.1
41		22.0	22.0	92.3	33.3		47.7	217.3	1.1
42			27.7	56.7	57.0	53.3		194.7	1.0
43		41.3	237.0	85.0	232.0		28.0	623.3	3.2
44		42.7	97.7	88.0	105.0	340.3	57.0	730.7	3.8
45	70.3	360.0	731.3	1,033.7	1,754.0	2,154.3	662.0	6,765.7	34.7
46	37.7	102.0	77.3	571.0	710.3	142.3	141.0	1,781.7	9.1
47		32.0	56.0	80.0	135.7	164.3	31.7	499.7	2.6
48	27.0	184.0	245.7	506.3	594.7	602.0	693.3	2,853.0	14.7
49	31.0	195.0	659.3	1,000.3	1,247.7	1,145.7	197.0	4,476.0	23.0
50		24.7			60.7	27.0		112.3	0.6
51					27.7			27.7	0.1
52		48.7	26.7		12.3	23.7		111.3	0.6
53		27.0	29.0		44.7			100.7	0.5
54		–	–					–	–
55		47.0	58.7					105.7	0.5
56			24.3		61.0	44.3		129.7	0.7
57	12.3	30.0	26.7			44.3		113.3	0.6
	214.3	1,225.7	2,429.0	3,695.0	5,252.3	4,798.3	1,857.7	19,472.3	100
	Percentage by Loaded Draft								
	1.1	6.3	12.5	19.0	27.0	24.6	9.5	100	

Source: USACE, NDC detailed files.

Note: Totals may not add due to rounding.

Table 3-9
Freeport Crude Petroleum Imports Vessels by Vessel DWT and Loaded Draft Range

DWT 1,000s	2004 Inbound Vessels by Loaded Draft Range					
	30–34	35–37	38–40	41–42	Total	
<80	1	4	17	1	23	8.3%
80–84.9	0	4	5	0	9	3.2%
85–89.9	0	0	2	1	3	1.1%
90–94.9	2	7	8	1	18	6.5%
95–99.9	9	20	20	52	101	36.3%
100–104.9	0	9	6	9	24	8.6%
105–109.9	3	14	36	15	68	24.5%
110–114.9	6	1	14	4	25	9.0%
140–155	3	1	2	0	6	2.2%
>155	1	0	0	0	1	0.4%
Total	25	60	110	83	278	100%
Trips (%)	9.0	21.6	39.6	29.9	100	
	2005 Inbound Vessels by Loaded Draft Range					
<80	0	5	22	3	30	9.3%
80–84	0	0	2	0	2	0.6%
85–89	0	0	1	0	1	0.3%
90–94	4	6	35	16	61	19.0%
95–99	2	0	5	0	7	2.2%
95–99.9	7	9	36	5	57	17.8%
100–104.9	1	3	16	4	24	7.5%
105–109.9	10	9	66	18	103	32.1%
110–114.9	1	2	18	4	25	7.8%
140–155	5	2	0	0	7	2.2%
>155	1	0	3	0	4	1.2%
Total	31	36	204	50	321	100%
Trips (%)	9.7	11.2	63.6	15.6	100	
	2006 Inbound Vessels by Loaded Draft Range					
<80	7	3	11	4	25	7.6%
80–84	0	0	0	0	0	–
85–89.9	0	0	1	0	1	0.3%
90–94.9	5	5	21	20	51	15.6%
95–99.9	2	2	23	31	58	17.7%
100–104.9	0	0	2	0	2	0.6%
105–109.9	1	1	10	0	12	3.7%
110–114.9	5	21	80	44	150	45.9%
140–155	3	11	5	0	19	5.8%
>155	1	0	8	0	9	2.8%
Total	24	43	161	99	327	100%
Trips (%)	7.3	13.1	49.2	30.3	100	

Source: USACE, NDC compiled from detailed records. The Fairplay/Lloyd's Register of Ships was used to obtain the vessel DWT and associated characteristics.

Tables 3-10 to Table 3-16 provide additional detail on the relationship between loaded and design drafts for Freeport's crude oil imports. Table 3-10 to Table 3-15 provide matrices of 2005 to 2007 annual inbound vessels and imports by loaded draft and design draft. Table 3-16 summarizes the inbound vessel and tonnage data and shows that 50 percent of 2007 tonnage was transported in vessels with loaded drafts over 40 feet.

Table 3-10
2005 Crude Petroleum Short Tons (1,000s)[a]
by Design Draft and Loaded Draft

Design Draft (feet)	Loaded Draft (feet)															Grand Total
	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
36									44							44
40									108		309	85	529			1,031
42									83			57	58	160	64	422
43					59		65		74	167	97	158	296		84	998
44							52		199			170	236		171	829
45	169		120			349		77	166	365	261	1,148	2,957		1,560	7,171
46		39			77					70	236	316	1,173		361	2,273
47										168		162	251	89	95	765
48	81					162		70	83	73	424	231	1,468	82	931	3,605
49			62	83	7	67	61		145	155	284	504	1,325	328	159	3,181
52			69			77							37			183
53					81			74								155
55				70												70
56									73				100			173
57					59											59
Grand Total	249	39	251	154	283	655	178	222	975	999	1,611	2,830	8,430	659	3,425	20,959

Source: USACE, NDC compiled from detailed records. The Fairplay/Lloyd's Register of Ships was used to obtain the vessel DWT and associated characteristics.

[a]Obtained from the USACE, detailed records, totals may differ from IWR-NDC publication. The presentation only includes records that showed loaded draft and for which design drafts could be found.

Note: Totals may not add due to rounding.

Table 3-11
2005 Crude Petroleum Vessels by Design Draft and Loaded Draft[a]

Design Draft (feet)	Loaded Draft (feet)															Grand Total
	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
36									1							1
40									2		4	1	8			15
42									1			1	1	2	1	6
43					1		1		1	2	2	2	4		1	14
44							1		3			2	3		2	11
45	2		3			4		1	2	5	4	16	37		18	92
46		1			1					1	3	4	13		4	27
47										2		2	4	1	1	10
48	1					2		1	1	1	7	3	19	1	11	47
49			1	1	1	1	1		2	2	4	8	20	4	2	47
52			1			1							1			3
53					1			1								2
55				1												1
56									1				1			2
57					1											1
Grand Total	3	1	5	2	5	8	3	3	14	13	24	39	111	8	40	279

Source: USACE, NDC compiled from detailed records. The Fairplay/Lloyd's Register of Ships was used to obtain the vessel DWT and associated characteristics.

[a]Obtained from the USACE, detailed records, totals may differ from IWR-NDC publication. The presentation only includes records that showed loaded draft and for which design drafts could be found.

Table 3-12
2006 Crude Petroleum Short Tons (1,000s) by Design Draft and Loaded Draft[a]

Design Draft (feet)	Loaded Draft (feet)																Grand Total
	25	26	28	30	31	32	33	34	35	36	37	38	39	40	41	42	
36										170							170
41		27						66	66				220	100		79	558
42													59	113			172
43									68		67			162			297
44							17							79	490		586
45				69		86	111	96	202	223	386	93	1,003	1,978	3,143	70	7,460
46							58	171	71			168	291	958	247		1,964
47												78		82			160
48					38					77			291	24	163	91	684
49	46			56			63		151	567	514	684	930	1,819	2,360		7,190
50						74								182	81		337
51														83			83
53									13					134			147
57			37						80								117
Grand Total	46	27	37	125	38	160	248	333	651	867	967	1,023	2,795	5,884	6,563	240	19,925

Source: USACE, NDC compiled from detailed records. The Fairplay/Lloyd's Register of Ships was used to obtain the vessel DWT and associated characteristics.

[a]Obtained from the USACE, detailed records, totals may differ from IWR-NDC publication. The presentation only includes records that showed loaded draft and for which design drafts could be found.

Note: Totals may not add due to rounding.

Table 3-13
2006 Crude Petroleum Vessels by Design Draft and Loaded Draft[a]

Design Draft (feet)	Loaded Draft (feet)															Grand Total
	25	26	28	30	31	32	33	34	35	36	37	38	39	40	41	
40														2		2
41		1						1	1				3	2	1	9
42													1	2		3
43									1		1			2		4
44							1							1	6	8
45				1		2	2	2	4	3	6	3	12	25	40	100
46							1	3	1			2	4	13	3	27
47												1		1		2
48					1					1			4	1	2	9
49	1			1			1		2	8	7	9	12	24	30	95
50						1								3	1	5
51														1		1
53									1					2		3
57			1						1							2
Grand Total	1	1	1	2	1	3	5	6	11	12	14	15	36	79	83	270

Source: USACE, NDC compiled from detailed records. The Fairplay/Lloyd's Register of Ships was used to obtain the vessel DWT and associated characteristics.

[a]Obtained from the USACE, detailed records, totals may differ from IWR-NDC publication. The presentation only includes records that showed loaded draft and for which design drafts could be found.

Table 3-14
2007 Crude Petroleum Short Tons (1,000s) by Design Draft and Loaded Draft[a]

Design Draft (feet)	Loaded Draft (feet)															Grand Total
	27	**28**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	
34						35										35
37				30												30
38	41															41
40	67		22	72			49		73	148	95	56				582
41												57				57
42												54				54
43									211	124			238			573
44				59					70	24	72	22		531		779
45		42	42	20	71		116	133	288	354	200	396	327	3,320	356	5,666
46		74						91			261	441		180	62	1,109
47				67	29								74	404		574
48				17	67	89	179	69	72	293	360	213	292	1,561	1,058	4,270
49		47			65	91	30		372	74	88	511	599	749	432	3,058
52								80						71		151
55					71				89	87						247
56													83	133		217
57				31										133		165
Grand Total	107	163	64	297	303	215	373	374	1,176	1,103	1,077	1,750	1,612	7,083	1,908	17,606

Source: USACE, NDC compiled from detailed records. The Fairplay/Lloyd's Register of Ships was used to obtain the vessel DWT and associated characteristics.

[a]Obtained from the USACE, detailed records, totals may differ from IWR-NDC publication. The presentation only includes records that showed loaded draft and for which design drafts could be found.

Note: Totals may not add due to rounding.

Table 3-15
2007 Crude Petroleum Vessels by Design Draft and Loaded Draft[a]

Design Draft (feet)	Loaded Draft (feet)															Grand Total
	27	**28**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	
34						1										1
37				1												1
38	1															1
40	1		1	2			1		1	2	2	1				11
41												1				1
42												1				1
43									3	2			3			8
44				1					1	1	1	1		6		11
45		1	1	1	1		2	2	4	5	3	5	4	38	4	71
46		1						1			4	5		3	1	15
47				1	1								1	5		8
48				1	1	1	3	1	1	4	5	3	4	18	12	54
49		1			1	2	1		5	1	1	6	8	8	5	39
52								1						1		2
55					1				1	1						3
56													2	2		4
57				1										1		2
Grand Total	2	3	2	8	5	4	7	5	16	16	16	23	22	82	22	233

Source: USACE, NDC compiled from detailed records. The Fairplay/Lloyd's Register of Ships was used to obtain the vessel DWT and associated characteristics.

[a]Obtained from the USACE, detailed records, totals may differ from IWR-NDC publication. The presentation only includes records that showed loaded draft and for which design drafts could be found.

Table 3-16
Crude Petroleum Imports by Loaded Draft
Number of Vessels and Short Tons

Number of Vessels by Loaded Draft Increment							
Year	**≤30 feet**	**31–35 feet**	**36–38 feet**	**39 feet**	**40 feet**	**≥41 feet**	**Total**
2005	9	21	51	39	111	48	279
2006	5	26	41	36	77	87	272
2007	7	29	48	23	22	104	233
% of Vessels by Loaded Draft Increment							
2005	3.2	7.5	18.3	14.0	39.8	17.2	100
2006	1.8	9.6	15.1	13.2	28.3	32.0	100
2007	3.0	12.4	20.6	9.9	9.4	44.6	100
1,000s of Crude Petroleum Import Short Tons by Loaded Draft Increment							
2005	539	1,492	3,585	2,830	8,430	4,084	20,960
2006	235	1,430	2,857	2,795	5,716	6,894	19,927
2007	334	1,562	3,356	1,750	1,612	8,991	17,605
% of Tons by Loaded Draft Increment							
2005	2.6	7.1	17.1	13.5	40.2	19.5	100
2006	1.2	7.2	14.3	14.0	28.7	34.6	100
2007	1.9	8.9	19.1	9.9	9.2	51.1	100

Source: USACE, NDC compiled from detailed records.

[a]Obtained from the USACE, detailed records, totals may differ from IWR-NDC publication. The presentation only includes records that showed loaded draft.

3.2.1.1 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. Figure 3-3 shows the U.S. Gulf offshore lightering zones.

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.

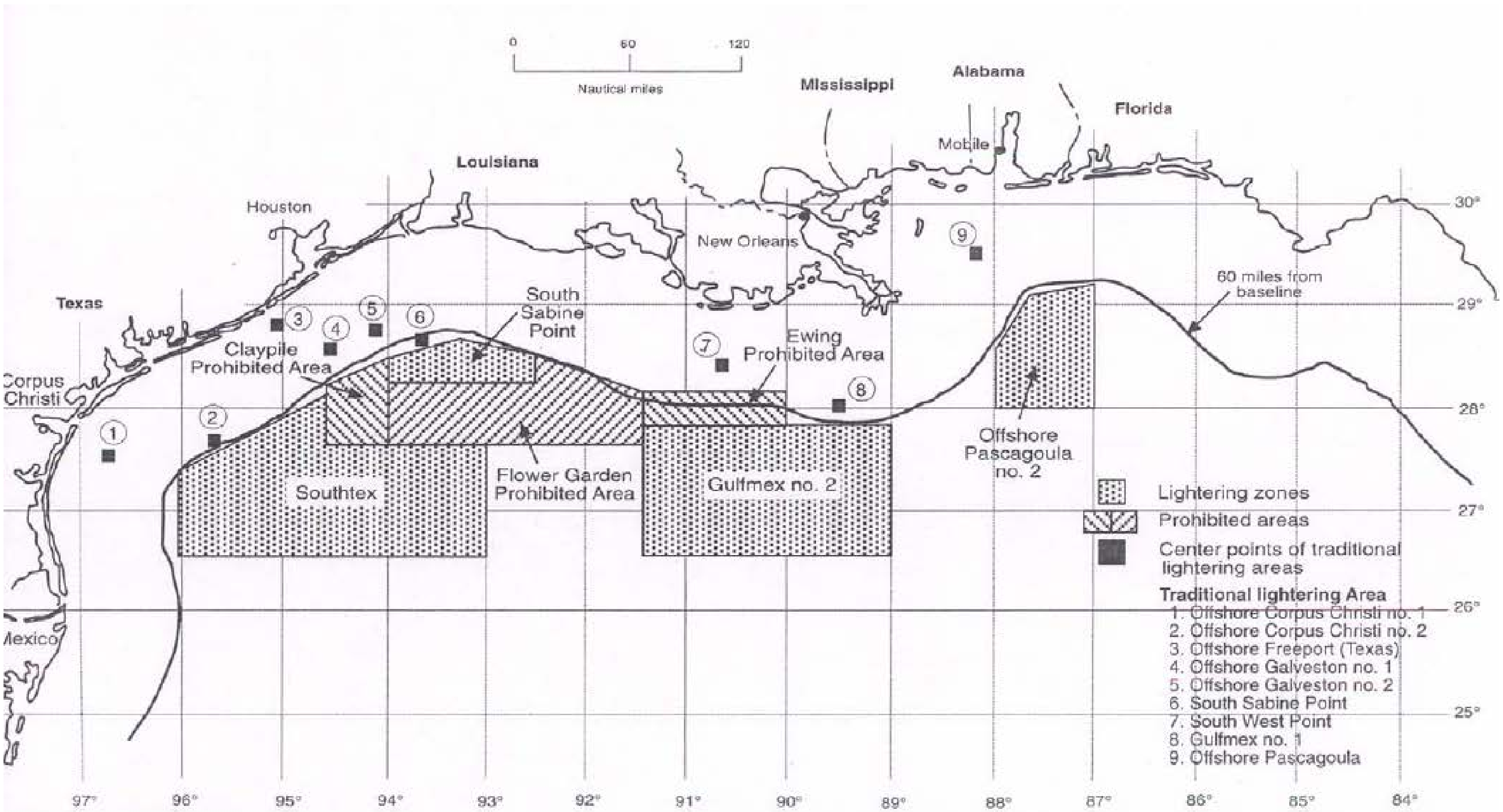
A frequent alternative to either direct shipment or lightering is lightening. The tanker sizes associated with lightening on the Texas Coast generally range from 120,000 to 175,000 DWT. Tankers larger than 175,000 DWT are normally lightered. There is a gap in the world tanker fleet between 175,000 and 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 3-17 presents Freeport's 2000 to 2009 crude petroleum imports by major trade route. The USACE NDC records only

Figure 3-3
U.S. Gulf Coast Crude Petroleum Lightering Zones



Source: Skaugen PetroTrans.

vessels that come into U.S. ports, such as Freeport, and do not include records of vessels that offload at the lightering zone.

In May 2008, British Petroleum (BP) signed an agreement with Petroterminal de Panama S.A. to modernize the pipeline and reverse shipments to transport BP's Angolan and other crude oil to the U.S. West Coast refineries. Future Ecuadoran movements are expected to use the Panama Canal.

Table 3-17
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 DOE.

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

Table 3-18 displays distribution of vessel sizes used for Central and South America routes. While the distributions show limited current utilization of vessels over 140,000 DWT for the Central and South America routes, vessels over 140,000 DWT are generally restricted from using Freeport due to its length and beam restrictions. The distribution of Central and South America tonnage by vessel size shows larger vessel sizes are employed in recent years in comparison to earlier periods.

Table 3-18
Distribution of Freeport Crude Petroleum Imports for Central and South America Routes by Vessel Class (2004–2006)
1,000s of Short Tons and Percentages[a]

Country of Embarkment	<50,000	60,000–79,999	70,000–79,999	80,000–89,999	90,000–99,999	100,000–119,999	>140,000	Grand Total
Bahamas	–	–	–	91.1	81.9	81.7	–	254.8
Colombia	–	200.2	–	236.2	334.0	233.7	–	1,004.1
Ecuador	–	113.7	–	–	–	–	–	113.7
Mexico	–	–	–	–	88.7	86.0	–	174.7
Panama	–	57.0	–	83.2	–	83.0	–	223.2
Venezuela	–	300.9	–	251.2	4,510.7	3,155.1	–	8,217.8
Annual Total 2004	–	671.8	–	661.8	5,015.2	3,639.5	–	9,988.3
2004 Distribution (%)	–	6.7	–	6.6	50.2	36.5	–	100
Bahamas	44.4	–	–	77.3	78.1	245.4	–	445.3
Brazil	–	–	74.9	–	77.3	219.2	–	371.4
Colombia	–	–	79.4	–	81.5	1,175.4	–	1,336.2
Ecuador	–	232.6	–	–	–	–	–	232.6
Mexico	–	114.1	115.9	–	235.8	110.2	–	576.1
Venezuela	–	126.4	177.5	78.2	3,663.1	5,560.4	–	9,605.7
Annual Total 2005	44.4	473.2	447.7	155.5	4,135.8	7,310.6	–	12,567.1
2005 Distribution (%)	0.3	3.8	3.6	1.2	32.9	58.2	–	100
Bahamas	–	88.1	–	–	165.8	398.1	–	652.0
Brazil	–	78.7	–	–	74.2	235.5	77.8	466.3
Canada	–	–	–	–	–	–	69.1	69.1
Colombia	–	37.1	–	–	163.5	44.7	–	945.3
Ecuador	58.5	–	–	–	52.9	–	–	111.4
Mexico	55.0	137.6	–	–	64.3	55.9	–	312.8
Venezuela	–	723.2	–	–	3,509.2	5,474.7	–	9,707.1
Annual Total 2006	113.5	1,064.8	–	–	4,029.9	6,908.8	146.9	12,263.9
2006 Distribution (%)	0.9	8.7	–	–	32.9	56.3	1.2	100

Source: USACE, NDC detailed files.

[a]Note: Totals may not add due to rounding.

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.

Table 3-19 presents the distribution of tonnage by loaded draft, trade route, and general method of shipment. The data show that direct shipments are loaded to greater drafts than vessels associated with lightering and lightening. The longer travel distances associated with direct shipments provide cost incentives to load vessels more fully.

Table 3-19
Freeport Crude Petroleum Imports
Estimated Distribution of Imports by
Loaded Draft, Trade Route, and Method of Shipment (Percent)

	Primarily Direct Shipment Routes				Primarily Lightened Tonnage Routes[b]			Lightering	
Loaded Draft (feet)	Mexico	Central and South America	Venezuela[a]	Western South America	North Sea and Europe	Western Africa	Africa & Europe Shuttle Vessels	Middle East Shuttle Vessels	Total
2003									
≤35	8.4	13.5	–	–	21.2	100	17.5	54.8	12.4
36–39	56.3	32.9	5.5	100	–	–	75.8	45.2	49.6
40–42	35.2	53.7	94.5	–	78.8	–	6.7	–	38.0
2004									
≤35	–	–	3.6	51.3	34.0	45.7	6.7	5.5	11.4
36–39	–	76.6	12.3	48.7	53.8	47.2	86.2	82.7	47.0
40–42	100	23.4	84.1	–	12.2	7.1	7.1	11.8	41.5
2005									
≤35	–	10.0	5.2	–	26.8	20.3	8.2	–	9.6
36–39	40.8	49.9	5.2	74.9	43.0	49.8	56.3	73.1	31.6
40–42	59.2	40.1	89.5	25.1	30.2	29.9	35.5	26.9	58.8

[a]97 percent of Freeport's Venezuelan crude oil imports are from the deepwater port of La Cruz. There are depth limitations at other Venezuela ports.

[b]Includes shuttle vessels

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 3-20 displays percentage distributions of Freeport's 1993 and 2007 imports by parcel size.

Table 3-20
Freeport Percentage of Crude Oil Imports by Vessel Parcel Size
1993 and 2007

	% of Imports by Parcel Size	
Vessel Parcel (short tons)	**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.

Table 3-21 and Table 3-22 present Freeport's 1993 and 2007 crude oil import distributions by parcel and vessel DWT range. The 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.

Table 3-21
Distribution of Freeport 1993 Crude Oil Imports by Parcel Size and Estimated DWT (Percent)

Parcel Size 1,000	Vessel DWT <50,000	60,000–75,000	75,000–89,000	90,000–99,999	115,000–139,999	140,000–159,000	Total
≤60	–	100	10	53	–	–	32
60–70	–	–	26	3	16	–	13
70–80	–	–	60	25	71	–	44
80–85	–	–	3	6	7	–	5
85–95	–	–	–	14	7	–	6
Total	–	100	100	100	100	–	100

Source: USACE, NDC compiled from detailed records

Table 3-22
Distribution of Freeport 2007 Crude Oil Imports by Parcel Size and Estimated DWT (Percent)

Parcel Size 1,000	Vessel DWT <50,000	60,000–75,000	75,000–89,000	90,000–99,999	115,000–139,999	140,000–159,000	Total
≤60	100	78	63	6	7	15	11
60–70	–	22	17	4	7	–	6
70–80	–	–	19	12	21	30	18
80–85	–	–	–	6	14	26	11
85–95	–	–	–	71	51	29	54
Total	100	100	100	100	100	100	100

Source: USACE, NDC compiled from detailed records

3.2.2 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.

Table 3-23 presents Freeport's 1990, 1993, and 2002 to 2009 petroleum product imports by loaded draft, and also includes total imports and maximum vessel loaded and design draft by year. The 2002 to 2009 records reveal an average of 32 percent of imports transported in vessels with loaded drafts over 40 feet.

Table 3-23
Freeport Petroleum Product Imports
by Loaded Draft (1990, 1993, and 2002–2009)

Loaded Draft (feet)	% of Petroleum Product Imports by Loaded Draft and Year									
	1990	**1993**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
<30	85	100	20	5	4	5	11	9	5	0
30–35	15	0	16	23	28	24	24	40	48	16
36–39	0	0	17	9	20	24	33	31	31	84
≥40	0	0	48	63	49	46	32	20	17	0
Total	100	100	100	100	100	100	100	100	100	100
Total Imports (1,000s of short tons)	17	18	736	1,857	2,873	1,779	1,080	1,046	955	220
% of Petroleum Product Imports Transported in Vessels With Loaded Drafts ≥40 feet and Year	0	0	48	63	49	46	32	20	17	0
Maximum Design Draft (feet)	33	28	49	53	56	53	49	54	54	49

Source: USACE, NDC detailed files.

Table 3-24 shows the distribution of Freeport's 1990, 1993, and 2002 to 2009 petroleum product exports. Vessels associated with petroleum product exports have maximum loaded drafts of 38 feet. The vessel sizes and trade route data indicate limited opportunities to load to increased drafts for the export market.

Table 3-25 shows world petroleum product fleet data compiled from the Lloyd's/Fairplay Vessel Register and includes the percentage of vessel DWT delivered between 2005 and 2009.

Table 3-24
Freeport Petroleum Product Exports
by Loaded Draft (1990, 1993, and 2002–2009)

Loaded Draft (feet)	% of Petroleum Product Exports by Loaded Draft and Year									
	1990	1993	2002	2003	2004	2005	2006	2007	2008	2009
<30	85	63	94	82	85	83	83	83	42	56
30–35	11	38	5	18	14	17	17	17	53	36
36–39	4	0	1	0	1	0	0	0	5	8
≥40	0	0	0	0	0	0	0	0	0	0
Total	100	100	100	100	100	100	100	100	100	100
Total Exports (1,000s of short tons)	26	25	119	87	91	91	109	89	81	126
% of Petroleum Product Exports Transported in Vessels With Design Drafts ≥40 feet and Year	0	0	0	0	0	0	0	0	0	0
Maximum Design Draft (feet)	36	35	37	34	35	36	35	35	38	38

Source: USACE, NDC detailed files.

Table 3-25
Petroleum Product Fleet

Design Draft (feet)	Median DWT	Percentage of Total DWT	
		Built 1985–2004	On Order as of Jan 2009
<36	13,000	13	4
36–38	38,500	14	2
39–40	46,000	23	13
41–42	47,000	26	12
43–44	68,000	5	12
45–46	85,000	7	0
47–49	99,900	9	45
50–51	110,000	2	12
	Total	100	100

Source: Lloyd's Vessel Register, 2009.

[a]Excludes crude oil and chemical tankers.

3.2.3 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[6]. The destination ports for these shipments include Brazil, Eastern Canada, and the Far East.

Table 3-26 shows 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 between 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 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.

Table 3-26
Freeport Chemical Product Exports
by Loaded Draft (1990, 1993, and 2002 to 2009)

Loaded Draft (feet)	% of Chemical Product Exports by Loaded Draft and Year									
	1990	1993	2002	2003	2004	2005	2006	2007	2008	2009
<30	46	53	42	39	31	31	39	35	35	39
30–35	35	43	39	43	44	44	31	50	41	30
36–39	19	4	17	13	15	18	19	10	17	24
≥40	0	0	2	5	10	7	11	5	7	7
Total	100	100	100	100	100	100	100	100	100	100
Total Exports (1,000s of short tons)	1,093	871	1,957	2,104	2,622	2,509	2,551	2,690	2,403	1,863
% Chemical Product Exports Transported in Vessels With Loaded Drafts ≥40 feet and Year	0	0	0	5	8	7	11	5	7	7
Maximum Design Draft (feet)	37	39	43	44	43	40	42	42	43	43

Source: USACE, NDC detailed files.

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

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.

Table 3-27 shows the destination for Freeport's 2003 to 2007 chemical product exports transported in vessels with loaded drafts of 40 feet or more. Data for 2008 to 2009 is not presented; however, 51 percent of 2009 exports for deeply loaded vessels were destined for China, 38 percent for Brazil, and the remaining 11 percent for Northern Europe.

Table 3-28 shows world chemical fleet data as compiled from the Lloyd's/Fairplay Vessel Register. The table shows that 21.7 percent of the chemical tanker DWT delivered through the end of 2009 have design drafts of 43 feet or more and 1.8 percent have design drafts of 47 feet or more.

Existing chemical carrier fleet data show the youngest fleet sector includes a large number of vessels between 30,000 and 49,999 DWT. This portion of the fleet represents over 50 percent of the total fleet. Tables 3-29 to 3-31 present data associated with the existing fleet and with vessels on order. The new vessel order data show a large increase in the number of vessels between 50,000 and 59,999 DWT.

Table 3-27
Freeport Chemical Product Exports by Destination (2003–2007)
for Vessels with Loaded Drafts Over 40 Feet (Percent)

Destination	2003	2004	2005	2006	2007
Antwerp, Belgium			0.1	2.5	
Belem, Brazil	24.0	56.8	27.2	34.0	34.2
Bombay, India			3.1		
Buenos Aires, Argentina					0.7
Durban, South Africa			0.5		
Itaqui, Brazil	12.0	39.6		10.0	
Jebel Ali, United Arab Emirates			0.3		
Jiangyin, China (Mainland)			1.3		
Kao Hsiung, China (Taiwan)			1.5	0.9	5.9
Kobe, Japan			0.6		
Merak, Indonesia			5.5		
Ning Bo, China (Mainland)			9.3	1.8	
Port Alfred, Quebec	37.7			7.3	18.7
Rotterdam, Netherlands		2.2	0.7	3.0	
Sao Paulo, Brazil	16.1		8.5		1.5
Shanghai					0.2
Singapore			11.3	6.9	5.6
Tai Chung			0.9	0.4	
Terneuzen, Netherlands		1.4	5.2	11.9	
Three Rivers, Quebec				1.4	5.5
Yokohama, Japan			0.7		
All Other Canada Atlantic Region Ports	10.2			4.2	2.6
All Other China (Taiwan) Ports			0.7		
All Other Japan Ports			2.1	2.7	1.3
All Other Peoples Republic of China Ports			6.3	1.4	8.5
All Other South Korea Ports			14.2	11.6	15.3
Total	100	100	100	100	100
Number of Unique Outbound Vessels	6	8	10	17	9

Source: USACE, NDC detailed files.

Table 3-28
Chemical Product Fleet

Design Draft (feet)	Median DWT	Percentage of Total DWT	
		Built 1985–2004	On Order as of January 2009
<36	13,000	36	34
36–38	38,500	24	19
39–40	46,000	24	18
41–42	47,000	7	6
43–44	50,000	4	22
45–46	85,000	1	0
47–49	95,000	5	2
50–51	n/a	–	–
	Total	100	100

Source: Lloyd's Vessel Register, 2009.

Table 3-29
World Chemical Product Fleet, Vessels Built Between 1985–2004

DWT Range	Total DWT	% of DWT	Median Vessel Characteristics				Year Built	No. of Vessels
			DWT	LOA	Beam	Design Draft		
<10,000	2,793,389	9.9	5,780	338	54	21	1997	505
10,000 to 20,000	3,479,986	12.4	14,364	454	71	29	1999	236
20,000 to 30,000	1,593,037	5.7	25,415	557	84	34	1998	61
30,000 to 39,999	6,544,848	23.3	37,068	599	91	36	2001	182
40,000 to 49,999	11,246,740	4.0	45,632	599	106	40	2000	252
50,000 to 59,999	568,838	2.0	50,600	600	106	44	1987	11
60,000 to 69,999	129,976	0.5	64,988	750	106	43	2000	2
70,000 to 79,999	146,521	0.5	73,261	749	106	47	1996	2
80,000 to 102,000	1,620,338	5.8	83,987	750	106	53	1988	19
Total	28,123,673	100				Number of Vessels		1,270

Source: Lloyd's Vessel Register, 2006.

Table 3-30
World Chemical Product Vessels Deliveries Between 2005-2009

DWT Range	Total DWT	% of DWT	Median Vessel Characteristics				Year Built	No. of Vessels
			DWT	LOA	Beam	Design Draft		
<10,000	4,145,481	9.1%	5,738	344	54	21	2008	741
10,000 to 20,000	10,403,885	22.9%	14,000	452	71	29	2008	693
20,000 to 30,000	1,543,504	3.4%	25,197	528	86	32	2008	63
30,000 to 39,999	7,163,102	15.8%	37,320	599	90	37	2007	195
40,000 to 49,999	12,378,645	27.2%	46,196	600	106	40	2007	274
50,000 to 59,999	9,047,468	19.9%	50,974	600	106	43	2008	177
60,000 to 69,999	0	-	-	-	-	-	-	0
70,000 to 79,999	589,654	1.3%	73,715	750	106	48	2008	8
80,000 to 102,000	207,261	0.5%	103,631	800	138	48	2007	2
Total	45,479,000					Number of Vessels:		2,153

Source: Lloyd's Vessel Register, March 2010.

Table 3-31
World Chemical Carrier Fleet Characteristics (2008)

Year Built	Total No. of Vessels by Year Built	% Vessels by Year Built	Total DWT	% of Total DWT	Average Vessel DWT	Average Vessel Design Draft (feet)	Mu DWT	Max DWT	Min Design Draft (feet)	Max Design Draft (feet)	Vessels With Design Drafts >40 feet	
											No.	Avg DWT
1985	70	3.6	1,075,046	2.6	15,358	27	379	59,999	10	44	9	49,440
1986	53	2.7	1,220,903	3.0	23,036	30	801	83,930	10	53	4	66,757
1987	31	1.6	1,064,255	2.6	34,331	34	1,195	83,970	14	53	14	57,083
1988	28	1.5	839,283	2.0	29,974	32	750	84,040	11	53	7	71,649
1989	17	0.9	412,598	1.0	24,270	28	1,185	84,040	13	53	3	84,040
1990	23	1.2	665,743	1.6	28,945	31	1,003	84,040	13	53	4	83,943
1991	34	1.8	437,957	1.1	12,881	25	1,142	45,998	13	40	0	–
1992	53	2.7	551,335	1.3	10,403	24	774	41,327	12	40	0	–
1993	29	1.5	298,030	0.7	10,277	24	1,104	41,354	13	40	0	–
1994	32	1.7	256,823	0.6	8,026	21	260	40,024	8	37	0	–
1995	36	1.9	720,009	1.8	20,000	29	670	47,629	11	42	2	46,314
1996	73	3.8	1,564,261	3.8	21,428	29	868	46,170	10	40	0	–
1997	65	3.4	1,279,517	3.1	19,685	29	3,159	47,198	18	41	1	47,198
1998	99	5.1	1,827,742	4.5	18,462	28	2,772	47,431	14	42	1	47,198
1999	100	5.2	2,079,420	5.1	20,794	29	2,700	47,363	14	40	0	–
2000	79	4.1	1,740,968	4.2	22,038	29	1,100	65,017	12	43	6	53,456
2001	76	3.9	1,672,751	4.1	22,010	29	1,100	47,087	12	42	1	47,087
2002	99	5.1	2,507,161	6.1	25,325	31	2,391	47,465	14	42	3	47,119
2003	127	6.6	3,592,330	8.7	28,286	32	2,945	71,522	14	45	6	51,932
2004	146	7.6	4,317,541	10.5	29,572	32	1,198	101,970	11	49	6	66,892
2005	256	13.3	5,517,612	13.4	21,553	28	711	101,970	13	46	21	52,770
2006	6	0.3	16,626	–	2,771	17	935	4,999	13	21	0	–
2007	82	4.2	941,427	2.3	11,481	23	390	51,218	9	43	4	50,801
2008	317	16.4	6,456,069	15.7	20,366	28	1,000	73,711	12	48	35	52,653
Grand Total	1,931	100	41,055,407	100	21,261						127	56,409

Source: Lloyd's Vessel Register, Compiled from 2004–2009 data extractions.

3.2.4 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.

3.2.5 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 thousand 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.

Table 3-32 displays changes in the general cargo and container vessels using U.S. ports between 1999 and 2006 and indicates 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.[7]

Table 3-32
U.S. Port Trends
Average Vessel Size Per Call
U.S. Total by Vessel Type

Year	General Cargo Vessels	Container Vessels	
	DWT	DWT	TEU
1999	21,783	37,262	2,585
2000	22,357	38,534	2,695
2001	23,416	39,656	3,801
2002	23,496	42,158	3,020
2003	23,655	43,168	3,144
2004	24,542	43,610	3,234
2005	25,101	44,593	3,013
2006	25,446	46,598	3,445
Percentage Change 1999–2006	16.8%	25.1%	33.3%
Average Annual Growth Rate	2.2%	3.2%	4.2%

Source: U.S. Department of Transportation, Maritime Administration, U.S. Calls at U.S. Ports Snapshot, 2005 and 2006 publications.

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.[8] The

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

[8] 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

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.

Table 3-33 presents U.S. regional containership vessel movements by loaded draft and illustrates a higher concentration of loaded drafts over 40 feet in 2006 than in previous years. Table 3-34 presents 2003 to 2006 trips by loaded draft. Figure 3-4 provides a general illustration of regional changes in loaded draft patterns for 2003 to 2006.

Table 3-33
Total Container Vessel Trips by Loaded Draft (2006) for U.S. Ports

Vessels by Loaded Draft (feet)							
Region	**≤30**	**31–35**	**36–40**	**41–44**	**45–49**	**≥50**	**Total**
California	767	1,641	1,865	408	15	2	4,698
Northwest	254	594	390	105	3	–	1,346
Northeast	776	1,311	1,482	95	7	–	3,671
Southeast	2,813	2,854	2,009	107	13	–	7,796
Gulf Coast	621	615	102	–	–	–	1,338
Houston	343	423	54	–	–	–	820
Freeport	104	–	–	–	–	–	104
Other	602	149	43	1	–	–	795
Total	6,280	7,587	5,945	716	38	2	19,644

Source: USACE, NDC, Entrances and Clearance (public data), 2003–2006.

Table 3-34
Total Containership Trips by Loaded Draft to U.S. Ports
2003–2006

Loaded Draft (feet)	Vessel Trips By Loaded Draft (feet)			
	2003	**2004**	**2005**	**2006**
≤30	6,330	5,679	5,683	5,833
31–35	7,695	7,052	7,384	7,164
36–38	3,082	3,816	3,843	4,468
39	384	619	667	879
40	200	394	282	544
41	84	273	166	316
42	81	171	127	232
43	5	26	16	108
44	3	16	6	60
45	1	7	14	31
46	1	3	6	3
47	1	1	–	2
48	–	3	1	1
49	–	–	–	1
50	–	–	2	–
>50	–	–	4	2
Total Vessels	17,867	18,060	18,201	19,644

Source: USACE, NDC, Entrances and Clearance (public data), 2003–2006.

Figure 3-4
U.S. Total Containership Trips
Percentage of Trips by Loaded Draft (2003–2006)

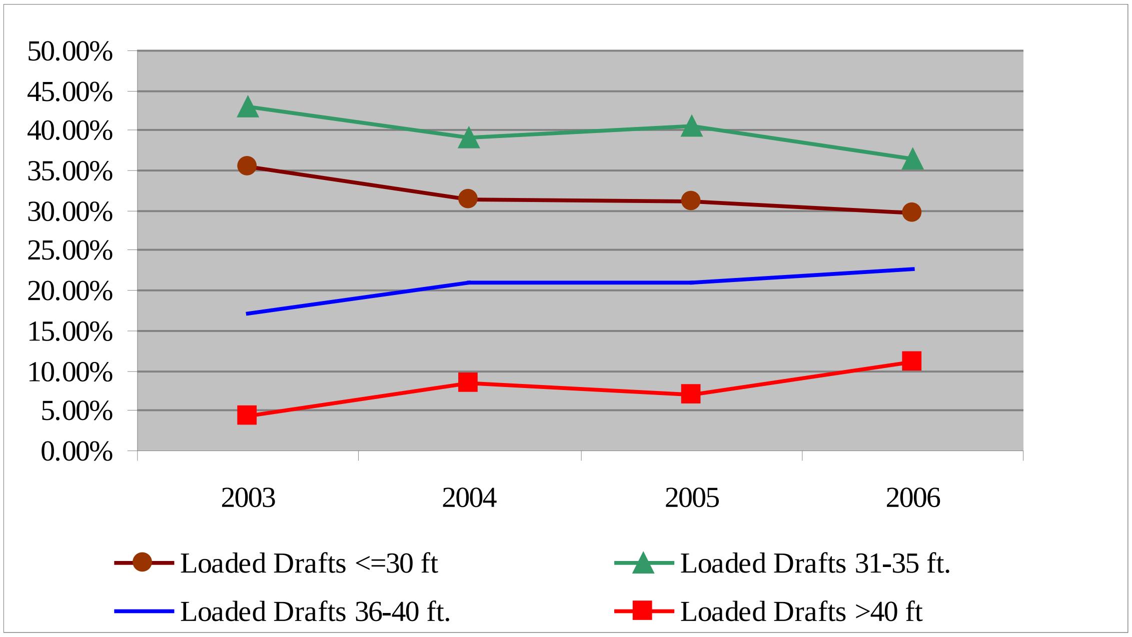


Table 3-35 displays 2006 Texas and U.S. container traffic by vessel DWT. The 2006 data illustrate a wide variance between the regional and the U.S. fleet distribution.

Table 3-35
Containership Traffic by Vessel DWT
Houston and U.S. Data (2006)

Vessel DWT	Vessel TEU	% of Houston 2006 Short Tons by Vessel Size	Estimated % of Houston 2006 Containership Trips by Vessel Size	% of U.S. 2006 Containership Trips by Vessel Size
22,900	1,400	11.4	24.7	66.2
33,900	2,300	18.1	11.3	22.7
45,400	3,400	37.3	19.9	4.5
55,600	4,000	24.0	8.8	2.8
62,949	4,800	2.1	15.8	0.9
67,652	5,000	5.1	12.6	0.2
≥80,596	6,500	2.0	4.4	2.8
	Total	100	100	100

Table 3-36 was prepared based on the distribution of loaded drafts for Houston 2006 container cargo.

Table 3-36
Distribution of Regional Cargo Tonnage by Loaded Draft (feet)

Vessel DWT	Design Draft	Loaded Draft (feet)			Standard Deviation
		Minimum	Median	Maximum	
22,900	34	17	28	37	3.25
31,900	37	25	32	39	2.67
40,300	40	25	32	38	2.30
42,800	42	23	32	39	2.61
46,400	44	26	32	39	3.06
55,600	45	27	33	40	2.36
65,000	46	26	36	40	2.81
>=80,700	47	32	35	39	1.86
Percentage of Tonnage by Loaded Draft and DWT Range					
22,900	34	1	97	2	100
31,900	37	13	72	15	100
40,300	40	12	86	2	100
42,800	42	19	77	3	100
46,400	44	12	66	21	100
55,600	45	10	81	8	100
65,000	46	3	63	34	100
>=80,700	47	10	64	27	100

Source: USACE, NDC, 2006

3.2.6 Offshore Supply, Seismic, and Research Vessels

Navigation constraints arose after the channel was deauthorized in 1974. A channel that is not 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 the BRPA revealed that they do not keep lists of vessels that are turned away. Based on the lack of records of vessels turned away, a detailed investigation of anecdotal information and vessel types similar to those presently using the Stauffer 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. The *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, but 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 6 to 7 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.

Table 3-37 displays a vessel list compiled from photo files provided by Freeport Launch. In addition to the vessels listed, the photo files include offshore rigs being transported to the Upper Stauffer Channel. The listing includes five vessels typed as "research survey vessels" and one vessel typed as "seismic survey vessel." The subtype classification for these six vessels is "seismic vessel."

Tables 3-37 and 3-38 summarize the range of loaded drafts for vessels presently using Galveston and Bayou Lafourche. The vessel drafts represent the range of vessels that Freeport has lost due to insufficient water depth and hazardous conditions. The focus of comparative port and fleet investigations was to determine sailing drafts, light drafts, and associated vessel characteristics. An additional focus was to help determine the range of loaded drafts for ports with less-restrictive depths. The *Kondor Explorer*, which moved to Galveston, will be returning to Freeport because the boarding charges are lower in Freeport and the port provides better security.

Table 3-37
Limited Vessel List for the Upper Stauffer Channel

Vessel Name	Loaded Draft	Estimated Light Draft[a]	Horse-power	Length Overall	Beam	Gross Tons	Net Registered Tons	Vessel Type	Flag
Brenda Lee	7	5	2050	–	25	99	67	Platform Supply Ship	U.S.
Brooks McCall	10	7	2400	160	40	806	564	Research Survey Vessel	U.S.
Christina	24	17	5384	328	56	4,320	2,260	General Cargo Ship	Norway Gibraltar
GGS Atlantic	13	9	2248	–	–	1,151	–	Research Survey Vessel	Marshall Islands
GSI Admiral	19	13	4801	297	64	3,435	1,031	Research Survey Vessel	Canada
GSI Pacific	14	10	2180	185	41	1,114	334	Research Survey Vessel	Panama
Jonathan Chouest	14	10	2248	180	40	1,096	341	Research Survey Vessel	U.S.
Kit Kat	7	5	2040	110	26	98	66	Crewboat	U.S.
Kondor Explorer	17	12	6004	200	46	1,163	2,048	Seismic Survey Vessel	Cyprus
Linda C	11	8	365	116	26	269	81	Utility Vessel	Cambodia
Milky Way	7	5	2050	110	26	98	66	Crewboat	U.S.
Miss Flo	9	6	1200	110	26	98	66	Platform Supply Ship	U.S.
New Yorker	–	–	–	–	–	–	–	Gambling Boat	–
Ocean Rover	–	–	–	320	266	18,871	5,661	Rig	Cayman Islands
Paul Candies	19	13	5697	140	42	–	785	Offshore Tug	Mexico
Stanco Traveler	8	6	1875	143	36	1,200	541	Platform Supply Ship	U.S.
Sunday Silence	7	5	2040	110	26	98	66	Crewboat	U.S.
Twix	7	5	2040	110	26	98	66	Crewboat	U.S.

[a]Light drafts are not published for many vessels. This table includes estimated light drafts. Light draft would be applicable for transport without cargo and supplies.

Table 3-38
Offshore Supply Vessels
Range of Design and Loaded Drafts (feet)
Bayou Lafourche, Galveston, and Freeport (2006)

Inbound Offshore Supply				Outbound Offshore Supply			
Vessel Design Draft	Loaded Draft			Vessel Design Draft	Loaded Drafted		
	Minimum	Median	Maximum		Minimum	Median	Maximum
15	6	12	15	15	12	15	15
16	6	12	16	16	7	10	10
17	7	12	15	17	12	17	17
18	10	14	17	18	14	18	18
19	12	16	18	19	16	18	18
20	6	17	20	20	7	14	14
21	7	15	21	21	–	–	–
22	7	17	20	22	16	19	19
23	18	19	19	23	19	19	19
24	–	–	–	24	–	–	–
25	–	–	–	25	–	–	–
26	–	–	–	26	–	–	–
27	–	–	–	27	15	21	21
28	–	–	–	28	10	13	13
29	–	–	–	29	14	15	15

Source: USACE, compiled from NDC Entrances and Clearances File, 2006.

Table 3-39 shows the world fleet by design draft and U.S. versus foreign flag.

Table 3-39
World Offshore Supply Vessel Fleet by Design Draft
U.S. Flag and non-U.S. Flag
Vessels Built After 1974 or Under Construction as of November 2008

Design Draft (feet)	Flag					
	U.S. Flag		Foreign Flag		Total Vessels	
3	–	0.0%	109	2.8%	109	2.3%
7	121	14.3%	367	9.4%	488	10.2%
10	186	21.9%	506	12.9%	692	14.5%
13	312	36.8%	863	22.0%	1,175	24.6%
16	152	17.9%	962	24.5%	1,114	23.4%
20	63	7.4%	751	19.1%	813	17.0%
23	13	1.5%	258	6.6%	271	5.7%
26	–	0.0%	103	2.6%	103	2.2%
30	3	0.3%	4	0.1%	6	0.1%
Total	849	100.0%	3,923	100.1%	4,772	100.0%

Source: Lloyd's Register – Fairplay, PC Register of Ships, November 2008.

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 are displayed in Table 3-41. The largest increases are primarily associated with design drafts over 20 feet. The data presented in Tables 3-40 and 3-41 were used to identify the range of vessel drafts associated with the fleet that includes vessels using Freeport.

Table 3-40
Offshore Vessel Fleet by Design Draft
USCG, World Fleet, and U.S. Flag Fleet

Design Draft (feet)	World Offshore Vessel Fleet						U.S. Flag Vessels	
	Offshore Vessels Registered with the USCG[a]		Constructed after 1974		Constructed after 2000 or "On Order"		Louisiana and Texas Home Bases	
	Number	%	Number	%	Number	%	Number	%
≤12	231	41.9	1,422	33.7	375	19.5	469	56.4
13–14	146	26.5	398	9.4	95	4.9	91	11.1
15	82	14.9	410	9.7	165	8.6	80	9.6
16	28	5.1	502	11.9	308	16.0	67	8.1
17	18	3.3	244	5.8	141	7.3	21	2.5
18	1	0.2	127	3.0	55	2.9	25	3.0
19	1	0.2	293	6.9	196	10.2	11	1.3
20	14	2.5	313	7.4	219	11.4	32	3.8
21	6	1.1	181	4.3	113	5.9	20	2.4
22	3	0.5	139	3.3	113	5.9	4	0.5
23	3	0.5	56	1.3	36	1.9	9	1.1
24	5	0.9	25	0.6	23	1.2	–	0.0
25	3	0.5	31	0.7	20	1.0	–	0.0
26	–	0.0	54	1.3	48	2.5	–	0.0
27	–	0.0	10	0.2	5	0.3	–	0.0
28	1	0.2	15	0.4	15	0.8	2	0.2
29	–	0.0	–	0.0	–	0.0	–	0.0
30	9	1.6	1	0.0	1	0.1	0	0.0
Totals	551	100.0	4,225	100.0	1,928	100.0	832	100.0

Source: Lloyd's Register – Fairplay, PC Register of Ships, November 2008, and USACE, NDC website data.

[a]Offshore vessels registered with the USCG include U.S. and foreign flag vessels. The list of offshore vessels registered with the USCG was compiled from the USACE NDC website.

[b]The remaining lists shown in the table were compiled from the Lloyd's Register – Fairplay, PC Register of Ships, November 2008.

Note: Totals may not add due to rounding.

Table 3-41
World Offshore Supply Vessel Fleet
Comparison of Percentage of Vessels Built After 1974 and 2000

Design Draft (feet)	Constructed After 1974	%	Constructed After 2000 or "On Order"	%	% Constructed After 2000 or "On Order"
<=12	1,422	33.7	375	19.5	26.4
13–14	398	9.4	95	4.9	23.9
15	410	9.7	165	8.6	40.2
16	502	11.9	308	16.0	61.4
17	244	5.8	141	7.3	57.8
18	127	3.0	55	2.9	43.3
19	293	6.9	196	10.2	66.9
20	313	7.4	219	11.4	70.0
21	181	4.3	113	5.9	62.4
22	139	3.3	113	5.9	81.3
23	56	1.3	36	1.9	64.3
24	25	0.6	23	1.2	92.0
25	31	0.7	20	1.0	64.5
26	54	1.3	48	2.5	88.9
27	10	0.2	5	0.3	50.0
28	15	0.4	15	0.8	100.0
29	0	0.0	0	0.0	–
30	1	0.0	1	0.1	100.0
31	0	0.0	0	0.0	–
Total	4,225	100	1,928	100	45.6

Compiled from Lloyd's Register – Fairplay, PC Register of Ships, November 2008.

Note: Totals may not add due to rounding.

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. Table 3-42 presents comparison of the percentage of research vessels built after 1974 with the percentage built after 2000.

Table 3-42
World Research Vessel Fleet
Comparison of Percentage of Vessels Built After 1974 and 2000

Design Draft (feet)	Constructed After 1974		Constructed After 2000 or “On Order”		% Constructed After 2000 or “On Order”
	Number	%	Number	%	
≤12	321	47.1	55	45.1	17.1
13–14	96	14.1	2	1.9	2.5
15	39	5.7	2	1.9	6.2
16	31	4.6	1	0.8	3.2
17	31	4.6	7	5.7	22.6
18	18	2.6	1	0.8	5.6
19	45	6.6	5	4.1	11.1
20	18	2.6	8	6.6	44.4
21	15	2.2	6	4.9	40.0
22	17	2.5	13	10.7	76.5
23	11	1.6	2	1.6	18.2
24	10	1.5	2	1.6	20.0
25	13	1.9	8	6.6	61.5
26	8	1.2	5	4.1	62.5
27	4	0.6	4	3.3	100.0
28	3	0.4	0	0.0	0.0
29	0	0.0	0	0.0	–
30	1	0.1	0	0.0	0.0
Totals	681	100.0	122	100.0	17.9

Compiled from Lloyd’s Register – Fairplay, PC Register of Ships, November 2008.

The fleet statistics shown in Table 3-43 include vessels operating in the U.S. Gulf of Mexico.

Table 3-43
Seismic and Research Vessels
Range of Design and Loaded Drafts (feet)
Bayou Lafourche, Galveston, and Freeport (2006)

Inbound Offshore Supply				Outbound Offshore Supply			
Vessel Design Draft	Loaded Draft			Vessel Design Draft	Loaded Drafted		
	Minimum	Median	Maximum		Minimum	Median	Maximum
15	–	–	–	15	–		–
16	–	–	–	16	16	14	16
17	–	–	–	17	12	12	12
18	–	–	–	18	17	17	17
19	–	–	–	19	12	12	12
20	–	–	–	20	6	10	18
21	20	20	20	21	–	–	–
22	17	17	17	22	16	17	17
23	17	17	17	23	17	17	17
24	19	19	19	24	19	19	19
25	21	22	23	25	–	–	–

Source: USACE, compiled from NDC Entrances and Clearances File, 2006.

The fleet distribution of the vessels other than oilfield classifications was compiled from the Lloyd's Register of Vessels and Texas Gulf Coast ports. Table 3-44 summarizes the number of vessels by draft for the world fleet and Texas Gulf Coast ports.

Table 3-44
World Vessel Fleet and Texas Gulf Coast
(Excluding Offshore Vessels)
Maximum Vessel Length of 400 feet

Design Draft (feet)	World Fleet (Maximum Length of 400 feet) Vessels Constructed After 2000 (%)	Texas Gulf Coast Fleet (%)	Freeport's Estimated Repair Layberth Cargo Vessels	Percentage
≤12	n/a	3.4	2	3.4
13–14	20.3	9.2	4	9.2
15	7.3	10.1	5	10.1
16	7.2	8.4	4	8.4
17	6.8	3.4	2	3.4
18	8.3	2.5	1	2.5
19	8.8	1.7	1	1.7
20	9.1	8.4	4	8.4
21	7.5	8.4	4	8.4
22	7.6	5.9	3	5.9
23	5.1	6.7	3	6.7
24	1.9	10.9	5	10.9
25	3.1	5.0	2	5.0
26	1.9	2.5	1	2.5
27	1.1	0.0	0	0.0
28	1.9	4.2	2	4.2
29	0.8	4.2	2	4.2
30	0.9	5.0	2	5.0
31	0.5	–	0	–
	100.0	100.0	48	100.0

Source: Lloyd's Register – Fairplay, PC Register of Ships, November 2008 and USACE, detailed vessel files.

3.2.7 Liquefied Natural Gas

In addition to its large existing base of crude petroleum, petroleum and chemical products, and dry bulk deep-draft cargoes, the without-project future includes construction of an LNG terminal. Phase I of 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 1986.

3.2.8 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 and 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 and 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, including those in Texas.

4.0 WITHOUT PROJECT CONDITION

The maximum vessel sizes for crude oil for the existing condition in the first reach 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 without-project future 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 without- and with-project conditions, imports from origins that include Mexico, Guatamala, Venezuela, Colombia, and Brazil are shipped direct. Under the without-project future 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 lightering or lightening. This reduction is expected to result in transition to direct shipment. For lightening, 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 without-project 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 without-project future depth of 18 feet.

An off-channel berth area on the Lower Stauffer Channel 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 without-project future, the Upper Stauffer Channel would continue to serve OSVs. 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 without-project future.

Galveston represents the most likely alternative port for vessel operators that wish to use the Stauffer Channel for layberth and supplies. The without-project, as well as the with-project, 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.”

Distribution of Upper Stauffer Channel vessel traffic by design draft was calculated using the total number of vessels and the fleet distributions for supply, seismic, and cargo vessels. Application of the fleet distributions for the without-project future is summarized in Table 4-1.

Table 4-1
Number of Vessels per Year for Without-Project Future

Vessel Design Draft (feet)	Number of Vessels by Type		
	Offshore Supply	**Seismic**	**Cargo/Other**
<12	81	25	2
13–14	21	1	4
15	36	1	5
16	67	0	4
17	31	3	2
18	12	0	1
19	43	2	1
Most Likely	236	30	17
Maximum	291	32	19

5.0 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 (Reach 1 and Reach 2) was pursued based on the non-Federal sponsor and industry's interest in bringing in larger and more fully loaded crude petroleum tankers. In Reach 1, 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.

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6.0 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 100,000 short tons annually, were transported in vessels with design drafts over 45 feet and were 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.

6.1 CRUDE PETROLEUM IMPORTS

Freeport's crude petroleum tonnage forecast was prepared using Global Insight's September 2010 projections. IHS Global Insight is a private company that provides economic forecasts, industry analysis, and market intelligence for over 200 countries and 170 industries. Although the DOE also provides forecasts for crude petroleum imports, their forecasts show an outlook inconsistent with historical trends, tend to be more volatile and more easily politically tainted from year to year, and are based on national data. For instance, the DOE US energy consumption forecast for 2010 to 2025 was 20 to 25 percent higher in 2006 than in 2008, and has been reduced another 20 percent since 2008. The Government Accountability Office has also published material contradictory to DOE's recent forecasts. The Global Insight forecast is still significantly lower than historical trends, but it is more consistent from year to year and provides regional data more relevant to the Gulf Coast. Also, Global Insight forecasts are widely accepted throughout the USACE and have been used on numerous other projects in the Galveston District. Table 6-1 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 6-1
U.S. Crude Oil Imports Projection Comparison
Millions of Barrels Per Day

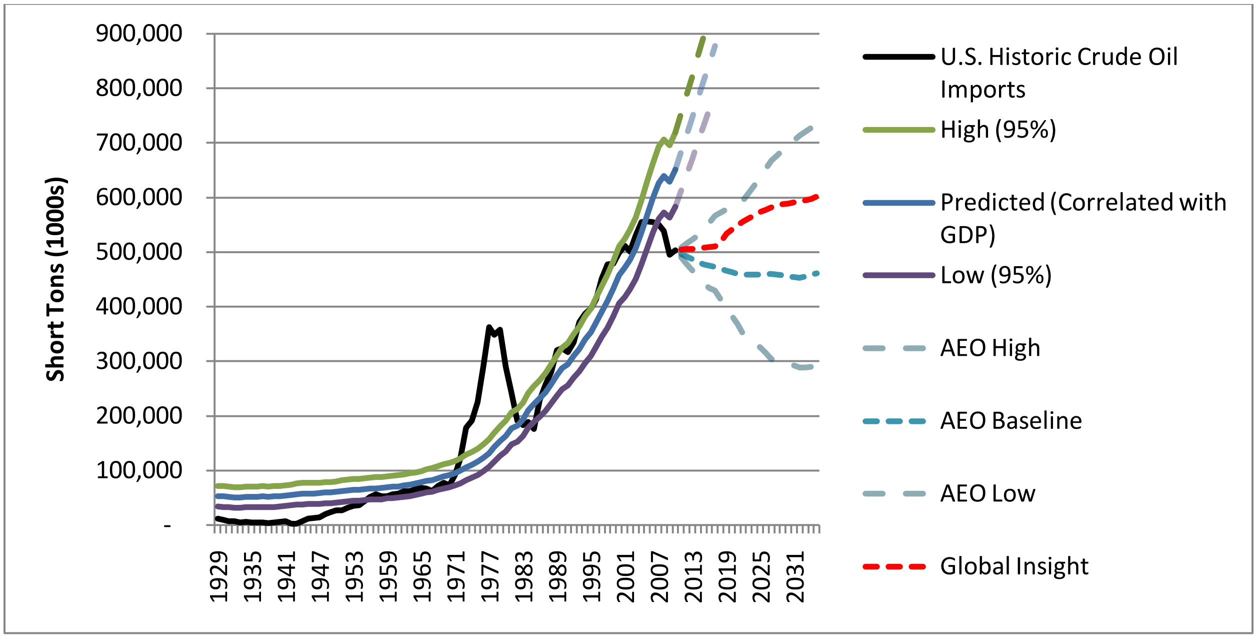
Year	AEO 2008	AEO 2009	AEO 2010	AEO 2011 (Preliminary)	Purvin and Gertz 2009	Global Insight 2008	Global Insight September 2010
2007	10.0	10.0	10.0	10.0	10.0	10.0	10.0
2015	10.2	8.1	9.0	8.9	11.1	n/a	9.6
2025	11.0	6.7	8.8	8.5	12.1	12.4	10.4
2030	11.9	7.0	8.8	8.4	12.5	12.7	10.5
2035	n/a	n/a	8.8	8.7	n/a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

Source: DOE, EIA, *2008 Annual Energy Outlook*, DOE/EIA-0383 (2008), *2009 Annual Energy Outlook*, DOE/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.

Figure 6-1 graphically shows the historic crude oil imports and the forecasts by AEO and Global Insight. The AEO high and AEO low display the range within AEO's forecast, with AEO baseline as their most likely prediction.

Figure 6-1
Historic and Projected U.S. Crude Oil Imports (1929–2035)



Contrary to the forecasts by DOE and Global Insight, the U.S. General Accounting Office (GAO) states that the United States relies on imported oil for more than half of its supply of energy and appears likely to increase its reliance in the future. Crude oil imports are anticipated to increase for several reasons. The primary reason is that there is a very high correlation between energy consumption and Gross Domestic Product (GDP) based on 80 years of historical data. As the economy grows, more energy is required. Given current technology, it is most cost effective and efficient to use oil as compared to other energy sources. Presently, according to GAO, other countries can provide oil cheaper than the U.S. Therefore, oil is imported into the U.S.

Another reason for crude oil imports to increase is population growth. According to industry, residential energy consumption steadily increases as population increases, and commercial energy consumption is more cyclical but also steadily increases over time. During recessions, commercial energy consumption may decrease slightly, which was experienced in 2009 to 2010. Per capita residential energy consumption has been relatively constant since the early 1970s. Contrary to historic trends, AEO's recent forecasts show per capita energy use decreasing by about 15 percent over the next 20 years, and by 2035, overall energy consumption increasing 20 percent less than the 60-year historic trend.

Also, despite DOE's projections of a 15 percent increase in energy consumption by 2035, DOE projects a decrease in crude oil imports due to an increase in liquefied natural gas and biofuel consumption. However, natural gas prices are currently at historic lows and likely will not remain at these levels over the next 30 years, and challenges must be overcome before biofuels can fill the gap in energy consumption. According to GAO, biofuels are 25 percent less efficient than gasoline and cannot increase production without a new form of technology. Ethanol production from corn has reached its maximum production capacity. Ethanol from cellulose is possible but costs twice as much to produce as corn so is not economically feasible presently. With current technology, the energy to produce a gallon of ethanol uses almost as much energy as it provides per gallon. Also, GAO argues that development of infrastructure is needed to increase production. Meanwhile, DOE reduced the funding for Research and Development in alternative energies by 85 percent from 1980 to 2006. Developing the infrastructure and technology to make alternative energies economically feasible will take several years and increased funding. GAO states the use of biofuels is optimistically expected to be 4 percent of overall energy consumption by 2015. Imported crude oil continues to be the cheapest form of energy per British thermal unit (BTU) for the United States. For this reason, an underlying assumption in the analysis is that companies will adapt for any potential supply-chain bottlenecks in the future to accommodate for demand.

Therefore, 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 6-2 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, in conjunction with Freeport's share of U.S. oil imports, was used in crude petroleum import calculations. Figure 6-2 displays Freeport's crude petroleum historical imports and forecast.

Table 6-2
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
% AAG 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.

Figure 6-2
Historic and Projected Freeport Crude Oil Imports (1990–2035)

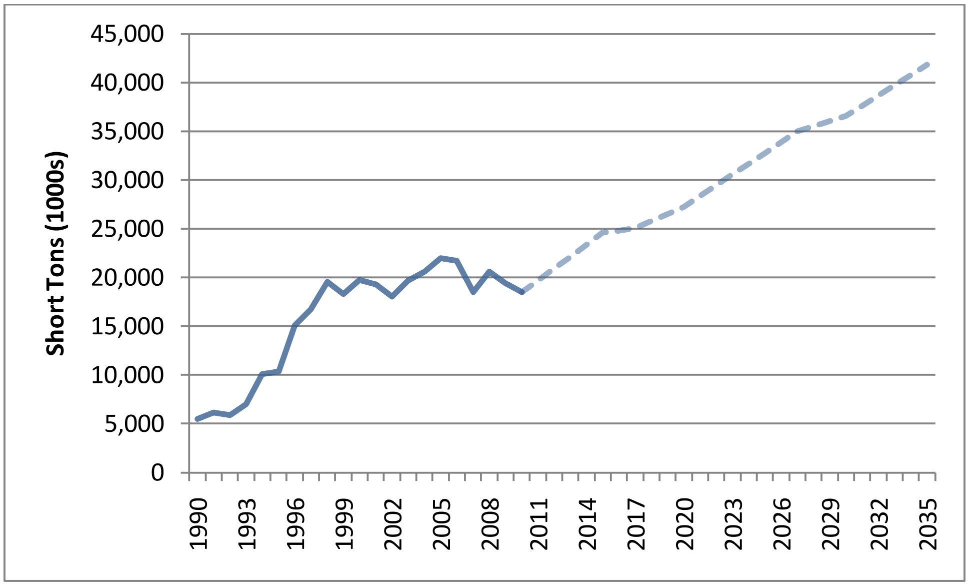


Table 6-3 displays the maximum cargo tons by vessel size and channel depth alternatives for representative vessels used in the analysis. The design draft is based on Lloyd’s Registry and empirical data at Freeport. An increase in Freeport’s channel depth from 45 to 50 feet would allow the existing range 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 6-3
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 6-4 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 will provide opportunities to reduce the number of shuttle vessels by using larger shuttles thereby providing transportation cost savings. For Suezmax tankers that are lightened to channel depth, an increase in channel depth will provide the ability to use smaller shuttles and reduce the overall transportation cost.

Table 6-4
Number of Shuttle Vessels Needed by Channel Depth Alternative[a]

DWT of Shuttle Vessel	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.

6.1.1 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 without- and with-project future. 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. The depths for the principal trading ports associated with 2002 to 2005 imports are shown in Table 6-5. 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.

Table 6-5
Port Depths at Major Ports Transporting Crude Oil to Freeport

Region and Port	Country	Depth (feet) Port or Region
North and South America		
High Seas, Gulf of Mexico	International Waters	76
Grand Bahamas, Freeport	Bahamas	76
All Other Brazil Ports North Of Recife	Brazil	75 at Itagui
All Other Colombia, Caribbean	Colombia	>45 at several Eastern Ports
Coatzacoalcos[a]	Mexico	42
Pajaritos[a]	Mexico	55
Tuxpan	Mexico	42
Cayo Arcas[a]	Mexico	72.2
Dos Bocas[a]	Mexico	89.9
Orangestad	Netherland Antilles	76
San Nicolas Bay	Netherland Antilles	76
Point A Pierre	Trinidad	52
Rio Haina	Trinidad	58
Puerto Miranda	Venezuela	39.5
Amuay Bay	Venezuela	41 to 45
Puerto La Cruz	Venezuela	55
La Libertad	Ecuador	Panama Canal Restriction[b]
Middle East		
Ras Tanura	Saudi Arabia	61–65
All Other Saudi Arabia Ports	Saudi Arabia	61–65 at Ras Tanura
Africa and North Europe		
Bonny	Nigeria	74.8
Kwa Ibo Terminal	Nigeria	85.3
Calabar	Nigeria	<40; planned improvements at Calabar
Sture	Norway	75.4

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.

[a]Located in the same region as the offshore Cayo Arcas, Mexico's offshore oil terminal. Cayo Arcas can load vessel drafts of up to 76 feet.

[b]The current Panama Canal's vessel draft limit is 39.6 feet. The vessel draft limit for the new canal chambers, which are under construction, is 49.2 feet, or 15 meters. The new lock chambers will fit vessels of 366 meters long and 49 meters wide.

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 limitation at the Venezuelan ports is 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 62 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 percentages 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. Freeport's 2000 to 2004 imports by country of origin or trade route with the U.S. is shown in Table 6-6.

Table 6-6
U.S. Total and U.S. Gulf Coast
Trade Route Forecast Distributions
Crude Petroleum Imports (Percent)

Trade Route	2000–2004 Period for U.S. Gulf, Freeport, and U.S. Total			U.S. Totals 2010–2030		
	Historical Base			Energy Information Administration Forecast		
	U.S. Gulf	Freeport	U.S. Total	2010	2020	2030
Mexico	25.2	3.8	15.6	14.3	13.8	13.3
Central and South America	25.4	43.0	19.1	15.6	15.8	16.6
Western South America	0.6	0.7	0.3	4.0	3.8	3.4
Mediterranean & Europe	7.5	8.4	7.1	5.2	4.9	4.4
Western Africa	9.5	8.0	13.6	15.3	15.0	15.2
Middle East	31.0	36.0	26.1	26.4	25.8	23.5
Far East	0.2	–	2.8	3.3	3.6	3.8
Canada	0.6	–	15.4	16.0	17.3	19.9
Total	100	100	100	100	100	100

Source: DOE, EIA, Early Release December 2007, Table 117.

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.

The AEO 2008 production forecast and projection of U.S. import trade routes show relatively high growth rates of U.S. imports from Latin America. In 2007, the Brazilian government signed contracts for the construction of 10 Suezmax tankers with the goal of modernizing state-run oil company Petrobras's fleet. Petrobras plans to acquire a total of 42 new ships between 2007 and 2015.[9] In 2007, 29 percent of vessels over 140,000 DWT using Freeport transported Brazilian crude oil imports.

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. Table 6-7 presents Freeport's 2005 to 2009 trade route distribution and application of the EIA's 2010 trade route forecast. 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. Table 6-8 shows the tonnage forecast used in the analysis by incorporating Global Insight's tonnage forecast for the U.S. and EIA's trade route forecast.

[9] Marine Digest and Cargo Business News, Summary for January 29–February 2, 2007.

Table 6-7
Distribution of Freeport Crude Oil Tonnage by Trade Route and Decade
2005/2009 and 2017/2027/2035

Trade Route	2005	2006	2007	2008	2009	2010	2017	2027	2035
	Percentage Distribution								
Canada	–	–	–	1	0	-	1	1	1
Mexico and E. South America	4	2	4	5	7	4	5	5	5
Venezuela and Colombia	58	52	49	44	32	58	40	37	37
Brazil and Argentina	4	4	4	2	11	4	7	9	9
Western S. America	1	1	0	0	4	1	10	11	11
Europe, Africa, and Mediterranean	9	14	9	16	20	9	13	13	13
W. Africa	21	13	17	17	19	21	20	20	20
Middle East	4	15	16	14	6	4	4	4	4
Pacific/Asia	0	0	0	0	2	0	0	0	0
	100	100	100	100	100	100	100	100	100

Source: Application of AEO2010 Trade Route Forecast.

Table 6-8
Freeport Crude Petroleum Import Tonnage
by Representative Trade Route and Decade (1,000s)
FY 2009 Vessel Costs December 2008

	2017	2027	2037	2047	2057	2067	Average Annual Growth (%)
Mexico	4,220	5,748	7,222	8,927	10,490	12,054	2.1
Central/South America	5,921	8,666	10,888	13,536	16,026	18,517	2.3
Europe and Africa	6,022	8,518	10,702	13,227	15,587	17,946	2.1
Middle East	8,913	12,063	15,157	18,281	21,458	24,636	2.2
Total Tonnage (1,000s)	25,076	34,994	43,969	53,971	63,562	73,153	2.2

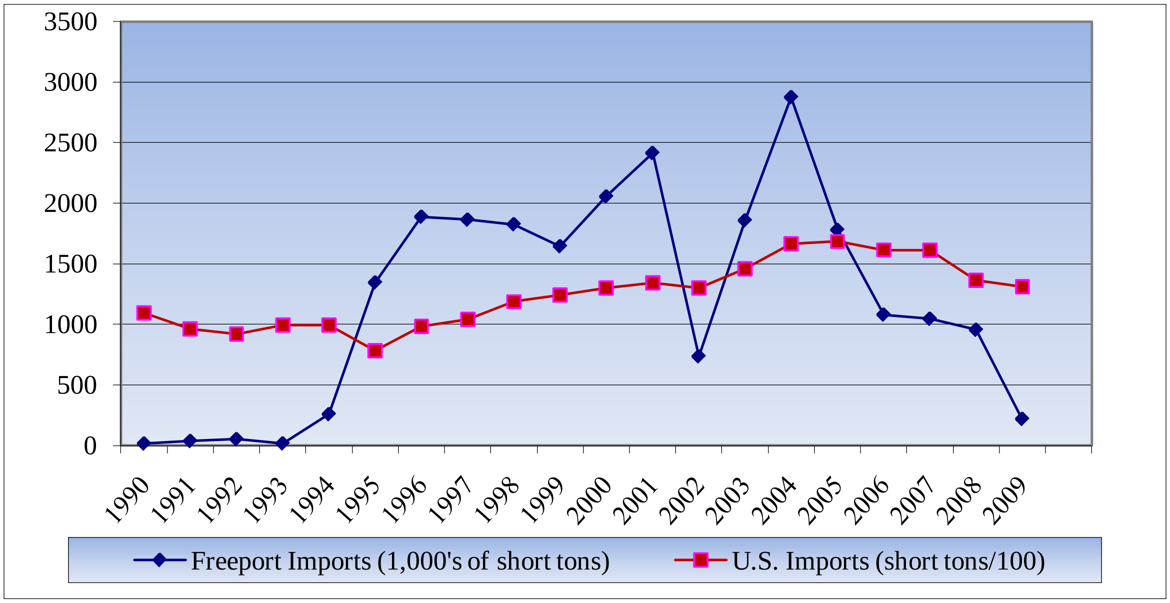
6.2 PETROLEUM PRODUCT IMPORTS

While experiencing tremendous growth in the early 1990s, petroleum product imports remained relatively constant since the mid-1990s before dropping in 2007, shown in Figure 6-3. 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.

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[10].

Figure 6-3
U.S. and Freeport Petroleum Product Imports 1990–2010



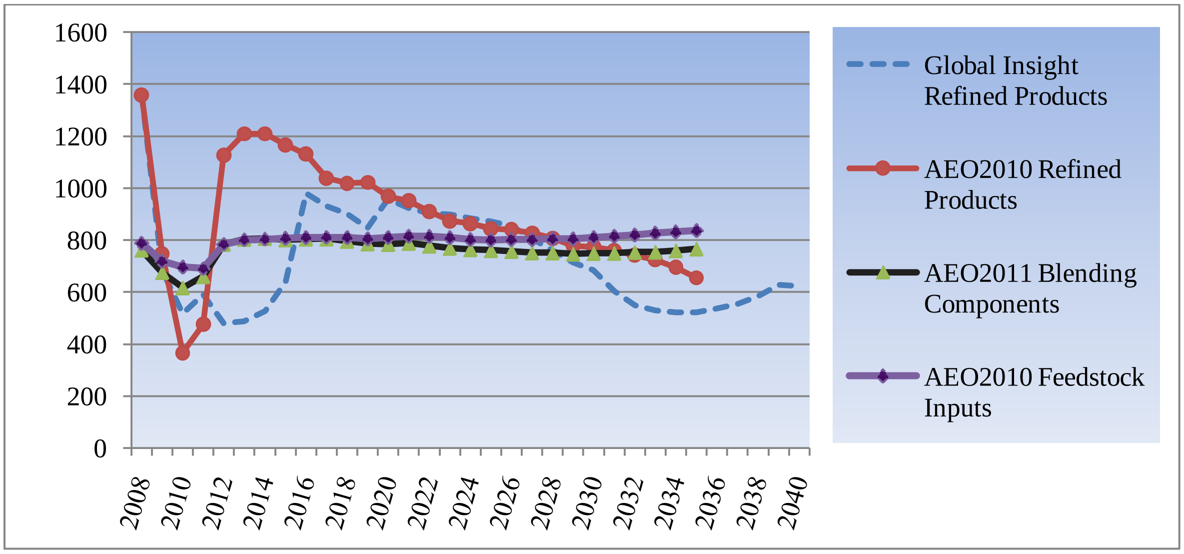
Source: USACE, Waterborne Commerce of the U.S. 1990-09.

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 2011 early release) show 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 AEO2011 early release projections (December 2010). The AEO2011 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. Figure 6-4 shows the AEO2011 and Global Insight forecast data. Imports of refined products are forecasted to decline by AEO and Global Insight. AEO shows partially refined products increasing to 2008 levels after 2013 and then remaining relatively steady for the remainder of the forecast period.

[10] 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

Figure 6-4
U.S. and Freeport Petroleum Product Imports (2008-2040)



Source: Aggregated from *2011 Annual Energy Outlook*, Report Number: DOE/EIA-0383ER(2011), Early Release December 2010. The Global Insight September 2010 forecast

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 ConocoPhillips 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.

Table 6-9 summarizes Freeport's petroleum product import forecast. Three scenarios are presented. The scenarios are based on application of the 2007 to 2009 to 2017 to 2035 U.S. growth rates for blending component and feedstock inputs to Freeport's 2007 to 2009 product imports. While specific sources and relative sulphur content of future crude oil imports is subject to uncertainty, the EIA and other experts have noted that the relative percentage of crude with high sulphur content is expected in the future. A higher percentage of high-sulphur crudes was imported in 2007, and a low percentage of high-sulphur crudes was imported in 2009. U.S. growth rate applied to Freeport's 2007 tonnage was used for base scenario used for the benefit calculations.

Table 6-9
U.S. and Freeport Petroleum Product Imports
Freeport Shift Share Percentage Application

Year	Blending Component	Feedstock Inputs	Total	Freeport Imports 1,000s of short tons		
	(millions of barrels/day)					
2007	0.72	0.75	1.47	1,046		
2008	0.76	0.79	1.55	955		
2009	0.68	0.72	1.40	220		
	Blending Component Forecast	**Feedstock Inputs Forecast**	**U.S. Total**	**Freeport Forecast**		
				2007 Base	**2008 Base**	**2009 Base**
2017	0.81	0.81	1.62	1,151	996	254
2020	0.78	0.81	1.60	1,135	983	251
2027	0.75	0.80	1.55	1,106	958	244
2030	0.75	0.81	1.56	1,111	962	245
2035	0.77	0.84	1.60	1,141	988	252

6.2.1 Petroleum Products Imports by Trade Route

Table 6-10 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.

Table 6-10
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

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 6-11 presents data associated with the ports of origin for Freeport’s 2003 to 2005 petroleum product imports transported in vessels with loaded drafts of 39 feet or more. 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.

Table 6-11
Port Depths at Major Ports Transporting Petroleum Products to Freeport (2003–2005)

Region	Port	Country	2003–2005 Total Tonnage for Vessels with Loaded Drafts ≥39 Feet		Channel Depth at Product Pier (feet)
			Short Tons	% of Total	
Mexico	Pajaritos	Mexico	59,073	1.7	55
Mexico	Dos Bocas	Mexico	58,329	1.6	72
Eastern South America	Puerto La Cruz	Venezuela	88,741	2.5	55
Western South America	Balao	Ecuador	55,889	1.6	51
Northern Europe	Wilhelmshaven	Fed Germany	31,757	0.9	51
Mediterranean	Elefsis	Greece	133,976	3.8	43
Mediterranean	Milazzo	Italy	90,303	2.5	52
Mediterranean	Mohammedia	Morocco	77,632	2.2	52
Mediterranean	Skikda	Algeria	104,651	2.9	52
Mediterranean	Arzew	Algeria	1,893,266	53.1	56
Middle East	Jebel Ali	United Arab Emirates	42,427	1.2	46
Middle East	Al Jubail	Saudi Arabia	32,626	0.9	50
Middle East	Jiddah	Saudi Arabia	38,546	1.1	51
Middle East	All Other Saudi Arabia Ports	Saudi Arabia	806,624	22.6	50
Middle East	Jebel Dhanna	United Arab Emirates	48,488	1.4	56
Total Tonnage For Vessels With Loaded Drafts ≥39 feet			3,562,328	100	
% of all Tonnage for All Loaded Drafts			62.5		

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.

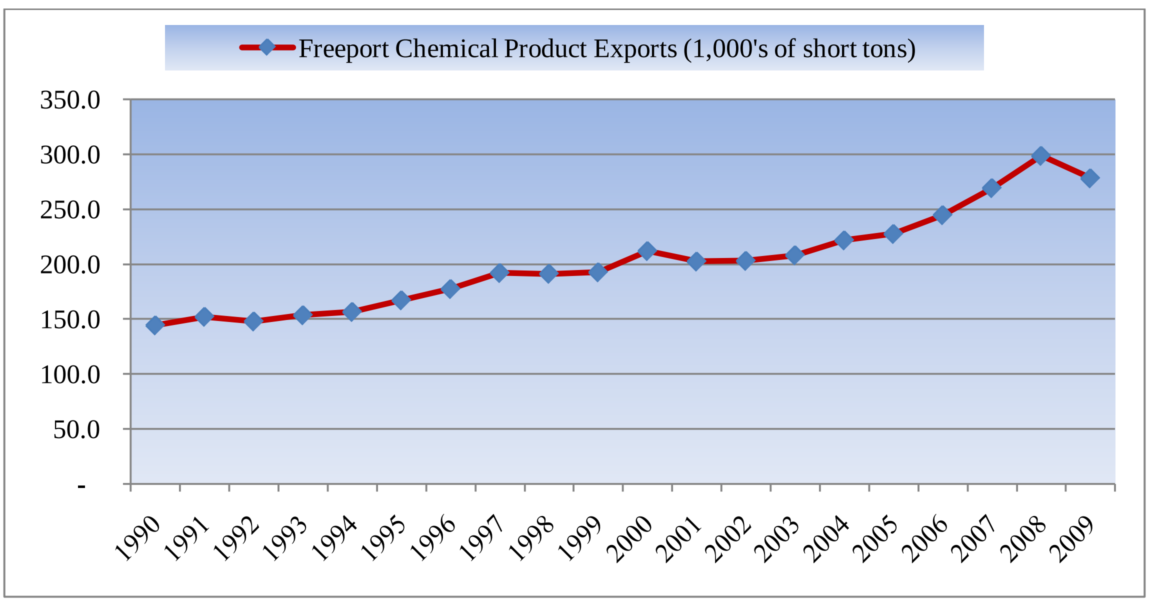
6.3 CHEMICAL PRODUCT EXPORTS

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 the 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 6-5 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 are displayed in Table 6-12. The trendline of Freeport's exports produced a more conservative forecast than the regression, so the trendline was used for the baseline estimate. Table 6-13 displays the result of the trendline equation data. Table 6-14 shows application of these estimates to base tonnage.

Figure 6-5
Freeport Chemical Product Exports (1990–2009)



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

Table 6-12
Regression Equation Data for
Freeport Chemical Product Export Forecast

Component	Description of Data and Outputs
Dependent Variable	Freeport Chemical Product Export Tonnage 1990–2009
Independent Variable	U.S. Industrial Materials & Supplies Export Value
Adjusted R Square	0.6774
No. of Observations	20
Degrees of Freedom	1
X Coefficient Level of Significance of t value	5.07E-06
F Statistic	40.90
Significance of F statistic	5.07E06

	Regression Equation Data		
	Base Output	Application of Standard Deviation	
		Minus 1	Plus 1
Constant	–426.57	–1,168.60	315.45
Standard Error of Y Estimate	332.79	332.79	332.79
X Coefficient: U.S. Industrial Materials & Supplies Export Value	0.01093	0.00734	0.014524

Historical Year	U.S. Industrial Materials & Supplies	Freeport (1,000s of Short Tons) 2005-09			
		Actual	Base Estimate[a]	Application of Standard Deviation	
				Minus 1	Plus 1
2005	227,475	2,509	2,060	501	3,619
2006	244,600	2,551	2,247	627	3,868
2007	269,175	2,691	2,516	807	4,225
2008	298,525	2,403	2,837	1,023	4,651
2009	278,100	1,863	2,614	873	4,354

Forecast Year	U.S. Industrial Materials & Supplies	Freeport Regression Based Forecast[a]		
		Base Estimate[a]	Application of Standard Deviation	
			Minimum	Maximum
2017	458,280	4,583	2,196	6,971
2027	683,351	7,044	3,848	10,240
2037	909,301	9,514	5,507	13,522
2040	977,504	10,260	6,007	14,512

Source: USACE, Waterborne Commerce of the U.S. 2001–2005, and Global Insight, 3rd Quarter 2007 Long-Term Forecast using Table Trd1A. Global Insight's forecast extends through 2040.

[a]Freeport 2027 Exports = –426.6 + (0.010932 * 683,351) with $683,351 being the forecasted value of U.S. industrial materials and supplies in 2027.

Table 6-13
Trendline Equation Output for
Freeport Chemical Product Exports

Component	Description of Data and Outputs
Dependent Variable	Freeport Chemical Product Export Tonnage 1990–2009
Independent Variable	Year
Adjusted R Square	0.783
No. of Observations	20
Degrees of Freedom	1
X Coefficient Level of Significance of t value	1.3398E-07
F Statistic	69.61
Significance of F statistic	1.34E-07

	Trendline Equation Data		
	Base Output	Application of Standard Deviation	
		Minus 1	Plus 1
Constant	–174,739.8	–219,186.6	–130,290.9
Standard Error of Y Estimate	272.9	272.9	272.9
X Coefficient: U.S. Industrial Materials & Supplies Export Value	88.29	66.05	110.52

	Freeport (1,000s of Short Tons) 2001–2005			
			Application of Standard Deviation	
Historical Year	Actual	Base Estimate[a]	Minus 1	Plus 1
2005	2,509	2,261	(86,753)	91,287
2006	2,551	2,355	(86,687)	91,397
2007	2,691	2,444	(86,621)	91,508
2008	2,403	2,532	(86,555)	91,618
2009	1,863	2,620	(86,489)	91,729

[a]Freeport 2020 Exports = –174,739.8 + (88.29 *2005) produced a base estimate of 2,267.1 for 2005.

Table 6-14
Freeport Chemical Product Exports Trendline Equation Residual Application

Year	Actual Exports	Predicted Exports	Residuals Values	Application of Absolute Residual Values		Factor Difference Between Predicted Exports and Absolute Residual Values	
				Minus	Plus	Minus	Plus
1990	1,093	942.8	150.2	943	1,243	0.86	1.14
1991	967	1,031.1	(64.1)	903	1,031	0.93	1.07
1992	871	1,119.4	(248.4)	623	1,119	0.71	1.29
1993	931	1,207.7	(276.7)	654	1,208	0.70	1.30
1994	1,431	1,295.9	135.1	1,296	1,566	0.91	1.09
1995	1,425	1,384.2	40.8	1,384	1,466	0.97	1.03
1996	1,418	1,472.5	(54.5)	1,363	1,473	0.96	1.04
1997	1,522	1,560.8	(38.8)	1,483	1,561	0.97	1.03
1998	1,724	1,649.1	74.9	1,649	1,799	0.96	1.04
1999	1,633	1,737.4	(104.4)	1,529	1,737	0.94	1.06
2000	2,217	1,825.6	391.4	1,826	2,608	0.82	1.18
2001	1,748	1,913.9	(165.9)	1,582	1,914	0.91	1.09
2002	1,907	2,002.2	(95.2)	1,812	2,002	0.95	1.05
2003	2,104	2,090.5	13.5	2,090	2,118	0.99	1.01
2004	2,622	2,178.8	443.2	2,179	3,065	0.83	1.17
2005	2,509	2,267.1	241.9	2,267	2,751	0.90	1.10
2006	2,551	2,355.3	195.7	2,355	2,747	0.92	1.08
2007	2,691	2,443.6	247.4	2,444	2,938	0.91	1.09
2008	2,403	2,531.9	(128.9)	2,274	2,532	0.95	1.05
2009	1,863	2,620.2	(757.2)	1,106	2,620	0.59	1.41
					minimum	0.59	1.01
					maximum	0.99	1.41
		Base		**Minimum[a]**	**Maximum[a]**		
		Exports		**Exports**	**Exports**		
2017		3,326		1,974	4,678		
2027		4,209		2,498	5,920		
2037		5,092		3,023	7,162		
2047		5,975		3,547	8,403		
2057		6,858		4,071	9,645		
2067		7,741		4,595	10,887		

[a]Minimum exports were calculated using the minimum absolute difference between 1990–2009 predicted exports and actual exports; this value was 0.59. Maximum exports were calculated using the maximum absolute difference between 1990–2009 predicted exports and actual exports; this value was 1.41.

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.

6.3.1 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 6-15 shows port depths at major ports receiving chemical products from Freeport.

Table 6-15
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	Kao Hsiung	China (Taiwan)	12,701	4.4	52
Pacific	Singapore	Singapore	36,140	12.6	46
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.

Table 6-16 shows the 2003 to 2006 trade route distribution presented for Freeport's chemical product exports were assumed to remain constant in the future.

Table 6-16
Freeport Harbor Chemical Product
Trade Route Distribution, 2003–2006
Representative Distribution by Major Trade Route (Percent)

Trade Route	Chemical Product Exports
Canada	17.2
Latin America	63.8
Northern Europe, Africa, and Mediterranean	10.0
Middle East and Far East	9.0
Total	100

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.

6.4 CONTAINER IMPORTS AND EXPORTS

Global Insight expected increases in domestic products after 2010, based on its April 2009 evaluations. Recent 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 6-17. Figure 6-6 presents Global Insight's 2006 to 2039 forecast of total expenditures, and Figure 6-7 presents their GDP forecast.

Table 6-17
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 6-6
U.S. Total Expenditure Forecast
Billions of Chained 2000 Dollars (2006–2039)

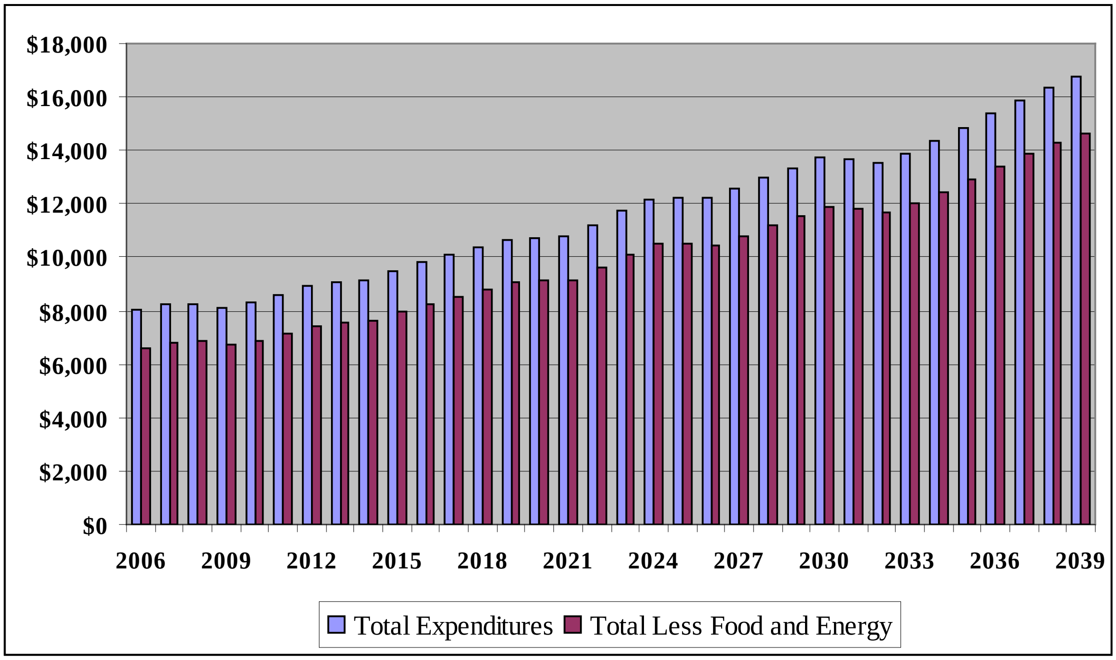
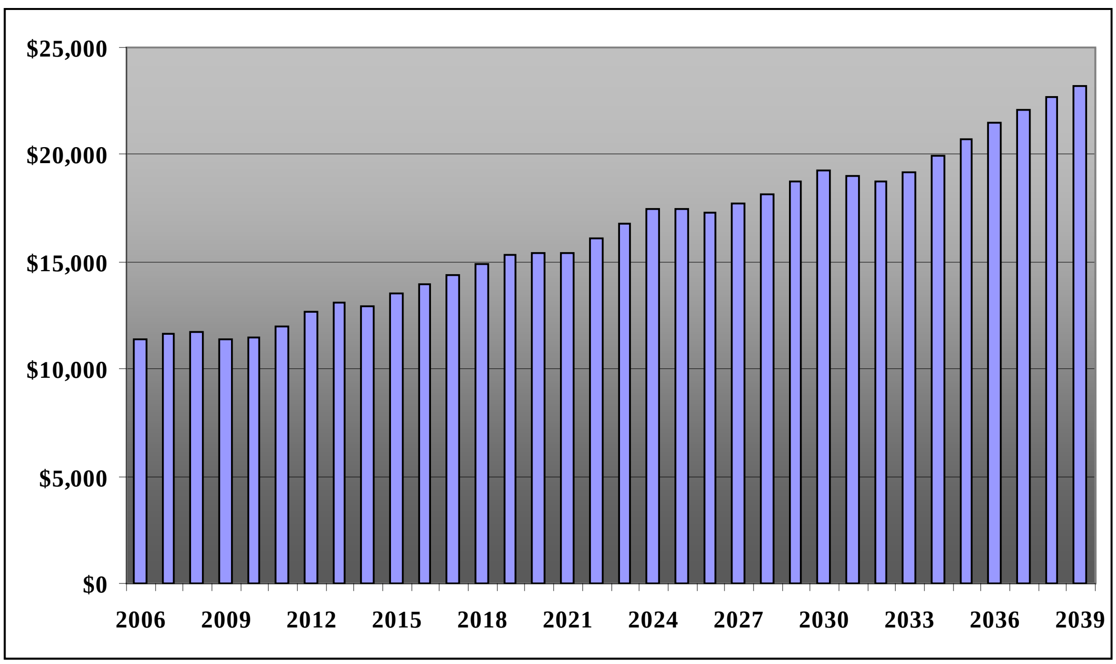


Figure 6-7
U.S. Gross Domestic Product Forecast
Billions of Chained 2000 Dollars (2006–2039)



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

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 a report by TxDOT entitled "Texas Ports 2007 to 2008 Capital Program."

U.S. demand for imported containerized goods is a function of domestic income, population, exchange rates, and other factors.[11] 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 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 Consolidated Metropolitan Statistical Area, 2009 data show 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 6-18.

Table 6-18
Houston-Galveston-Brazoria Consolidated Metropolitan Statistical 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

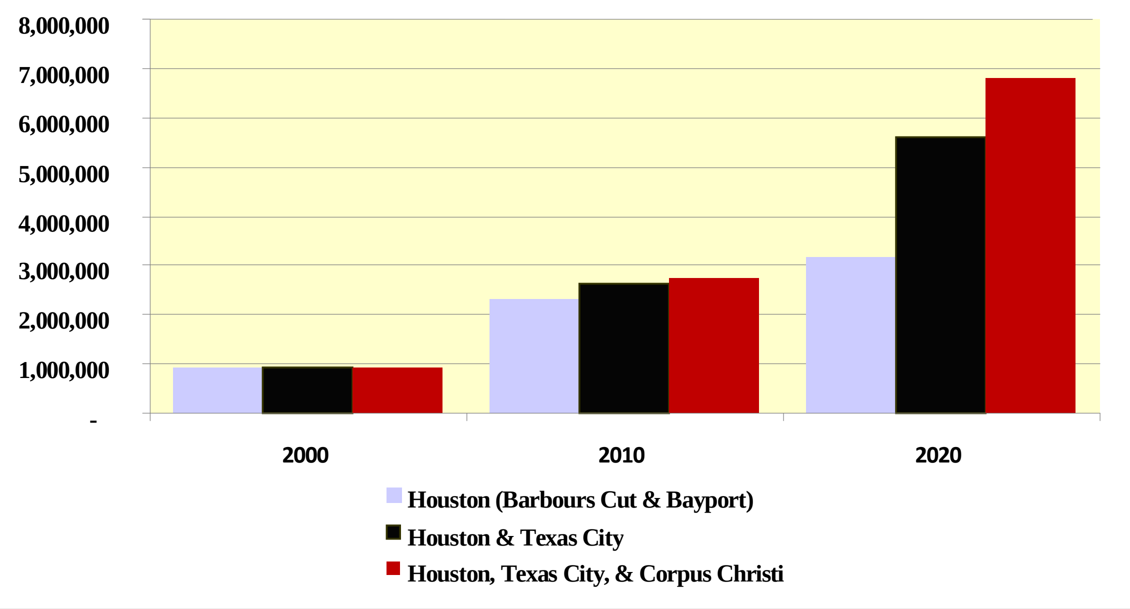
Source: Texas Water Development Board, 2006 Regional Water Plan, County Population Projections 2000–2060.

[11] 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

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 6-8 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 TEUs, and 2010 regional market demand between 2.2 and 2.4 million TEUs 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 TEUs shows 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.

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 and could not navigate past Station 180+00 but smaller containerships could. In order to safely accommodate this vessel, several other improvements to the channel, including widening, is necessary. Widening is needed around the Big Bend area inbound from the Seaway Dock at the lower end of the channel. 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.

Figure 6-8
Texas Container Cargo (TEUs) 2000-2020



Source: Compiled from port publications and general literature.

Table 6-19 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.

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.

Table 6-19
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 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. UP's relocation of its major east-west intermodal rail 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.[12]

Although Global Insight projects a 4.8% annual increase in container value until the year 2039, this analysis uses an average annual increase in tonnage of 0.2% 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 terminal is also expected to meet increased long-term demand resulting from higher than anticipated regional population growth.

6.4.1 Container Imports And Exports by Trade Route

Table 6-20 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

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

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 include South America and Central America, Europe and Africa, and the Mediterranean and Asia.

Table 6-20
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	*Altantic 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 Havre	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.

6.5 UPPER STAUFFER

The Minerals Management Service (MMS) 2009 to 2018 U.S. Gulf of Mexico oil and gas forecast shows production potentially peaking at 1.8 million BPD. Table 6-21 displays the MMS forecast.

Table 6-21
Gulf of Mexico (GOM) Annual Oil Production Rates (1,000s Barrels/Day)

Year	Shallow Water Historical	MMS Shallow Water Projection	Deepwater Historical	Industry Deepwater Projection	MMS Deepwater Projection	Committed Scenario Total GOM	Industry Deepwater Projection	Undiscovered Resources	Full Potential Scenario Total GOM
1981	719								
1987	892								
1997	830		296			1,126			
1998	781		436			1,217			
1999	738		515			1,353			
2000	690		743			1,433			
2001	667		864			1,531			
2002	601		955			1,556			
2003	577		957			1,534			
2004[a]	513		953			1,466			
2005[a]	387		892			1,279			
2006[a]	357		929			1,286			
2007[a]	381		895			1,276			
2008[b]	313		829			1,142			
2009[c]		288		925		1,213	0	2	1,215
2010[c]		251		1,140		1,391	7	7	1,405
2011[c]		218		1,417		1,635	13	18	1,667
2012[c]		190		1,418		1,608	94	33	1,735
2013[c]		165		1,393		1,558	241	80	1,879
2014[c]		144			1,226	1,369	341	138	1,849
2015[c]		125			1,079	1,204	425	205	1,833
2016[c]		109			949	1,058	463	288	1,909
2017[c]		95			835	930	431	399	1,760
2018[c]		82			735	817	410	508	1,735

Source: U.S. Department of Interior, MMS, Gulf of Mexico Oil and Gas Production Forecast 2009–2018, OCS Report 2009-012, May 2009, p. 16.

[a]Years with known anomalies due to hurricane affect shut-in

[b]Estimate

[c]Projected

Table 6-22 summarizes the MMS "full potential" forecast and also includes the DOE's 2009 forecast. 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 DOE'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 (ARRA).

Table 6-22
Gulf of Mexico Annual Oil Production Rate Comparison
Minerals Management Service and
Annual Energy Outlook Forecasts
(1,000s Barrels/Day)

Year	MMS[a]	AEO[b]
1997/1999	1,334	1,334
2000/2002	1,540	1,540
2003/2005[a]	1,426	1,426[a]
2006/2008[a]	1,235	1,235[a]
2009	1,215	1,660
2010	1,405	1,851
2011	1,667	2,004
2012	1,735	2,090
2013	1,879	2,084
2014	1,849	1,985
2015	1,833	1,915
2016	1,909	1,868
2017	1,760	1,864
2018	1,735	1,913
2020	n/a	1,859
2030	n/a	2,098
Average Annual Growth Rates		
2006/2008 to 2018	3.1%	4.1%
2018–2030	n/a	0.8%
2006/2008 to 2030	n/a	2.3%

Source: U.S. Department of Interior, MMS, Gulf of Mexico Oil and Gas Production Forecast 2009–2018, OCS Report 2009-012, May 2009, p. 16,

[a]Includes years with known anomalies due to hurricane affect shut-in.

[b]DOE, Lower 48 Production, Table 114, "An Updated Reference Case Reflecting Provisions of the American Recovery and Reinvestment Act, April 2009.

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 to 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.

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 and indicated a base of 175 rigs will be served by vessels operating from Galveston or Freeport. Table 6-23 shows approximately 92 rigs are in close proximity to Freeport, and 83 are close to Galveston.

Table 6-23
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 MMS Maps, 2006.

An annual seismic vessel count of 55 was used for the 2008 base period. 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. 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.

Expansion of Freeport's OSV fleet is expected to include a similar range of loaded drafts presently using Galveston and Bayou Lafourche. The Galveston Channel has an operating depth of 45 feet and Bayou Lafourche has an authorized and operating channel depth of 24 feet. Table 6-24 shows the expected number of vessels per year to call at Freeport by vessel design draft.

Table 6-24
Upper Stauffer Estimated Number of Vessels per Year by Design Draft for With-Project Future

Vessel Design Draft (feet)	Number of Vessels by Type		
	Offshore Supply	Seismic	Cargo/Other
<12	81	25	8
13–14	21	1	5
15	36	1	2
16	67	0	4
17	31	3	1
18	12	0	4
19	43	2	4
20	48	4	3
21	25	3	3
22	27	6	2
23	8	1	2
24	5	1	3
25	5	4	2
26	10	2	2
27	1	2	0
28	3	0	1
29	0	0	1
30	0	0	1
Total[a]	420	55	48

Source: Application of vessel fleet distributions prepared using Lloyd's Register – Fairplay, PC Register of Ships, November 2008 and Freeport vessel trip estimates.

[a]Note: Totals may not add due to rounding.

The mileage zones and transportation time savings for each zone are shown in Table 6-25. 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 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.

Table 6-25
Stauffer Channel Difference in Transit Time (Hours)

Zone	Freeport Time (hours)	Galveston Time (hours)	Freeport Reduced Time (hours)
Zone A = 20 miles or less	2	4	2
Zone B = 40 miles or less	4	6	2
Zone C = 60 miles or less	6	8	2
Zone D = 80 miles or less	8	10	2
Zone F =115 miles or less	13	15	2

Source: Compiled from MMS Maps, 2006.

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7.0 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 with-project future would result in a greater number of 160,000 DWT vessels for crude petroleum. The maximum-sized chemical carrier under the with-project future 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 with-project future. 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.

7.1 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 the BRPA. The IWR Report 91-R-13 cargo capacity factors published in the deep-draft manual for dry bulk carriers and tankers are shown in Table 7-1. Consultation with industry and the BRPA revealed that these estimates are reasonable. Table 7-2 displays representative round-trip mileage for the trade routes or junction points used in the transportation cost computations. Table 7-3 presents the foreign flag double-hull vessel operating cost update used in the analysis. Table 7-4 presents the container vessel operating costs from IWR's Load Factor Tables. Tables 7-5 to 7-7 show the Load Factor tables from IWR for each region for container imports and exports used in the analysis.

Table 7-1
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 7-2
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	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 7-3
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 7-4
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 7-5
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 7-6
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 7-7
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 a 110,000 DWT foreign flag tanker as an example, is illustrated in Table 7-8. Similar computations were made for appropriate distances and vessel sizes for each of the channel depth alternatives.

Table 7-8
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.

7.1.1 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 without-project and with project conditions. Transportation costs and savings were calculated for vessels that minimize transportation costs given trade route constraints and pilot rules. One rule that the BRPA emphasized would not change between the without- and with-project conditions is underkeel clearance. The without- and with-project futures reflect changes in trade routes based on traffic forecast data.

Table 7-9 presents direct shipment costs for all routes. The transportation cost calculations were based on vessels sizes between 50,000 and 175,000 DWT, and then weighted by expected fleet distribution to get the most likely average cost per ton. Depths at trading ports and detailed analysis of current vessel use indicate that a significant share of Mexico and Latin American shipments would be likely to accrue benefits from increases in channel depth. Vessels from 60,000 to 120,000 DWT generally represent the range used for shipments from Mexico and Central and South America, with approximately 90 percent of 2004 to 2006 imports being shipped in vessels in the 90,000 to 120,000 DWT range. The per ton costs for direct shipment for the Central and South America routing shows significant reductions in costs for Suezmax vessels between 135,000 and 150,000 DWT for the 58- and 60-foot channel depth alternatives. Information obtained from Martin and Associates, who prepared the Freeport regional impact analysis, has indicated that transition would occur.[13] Freeport's 2006 and 2007 vessel transits show the use of Suezmax tankers for crude oil shipped from Brazil.

Table 7-10 presents the transportation costs per ton range for lightening for applicable trade routes. Table 7-11 presents the costs per ton range for lightering for applicable trade routes. Costs for offshore transfer approach the cost of direct shipment at greater channel depth alternatives.

[13] Personal communication, Martin and Associates, 2008.

Table 7-9
Crude Petroleum Transportation Cost Per Ton for Direct Shipments to Freeport

Channel Depth	45 feet	50 feet	52 feet	55 feet	58 feet	60 feet
DWT, Mexico						
50,000	3.79	3.56	3.56	3.56	3.56	3.56
60,000	3.72	3.33	3.33	3.33	3.33	3.33
70,000	3.52	3.05	2.98	2.98	2.98	2.98
80,000	3.92	3.33	3.16	2.93	2.87	2.87
90,000	2.89	2.60	2.60	2.60	2.60	2.60
100,000	2.89	2.58	2.51	2.51	2.51	2.51
110,000	2.93	2.61	2.51	2.46	2.46	2.46
120,000	2.97	2.64	2.54	2.41	2.41	2.41
135,000	3.10	2.76	2.65	2.51	2.42	2.42
150,000	3.04	2.69	2.58	2.44	2.32	2.27
165,000	3.17	2.80	2.69	2.53	2.41	2.33
175,000	3.08	2.72	2.60	2.45	2.32	2.25
Most Likely Average Cost	3.32	2.86	2.75	2.61	2.48	2.38
Central and South America						
50,000	10.31	9.60	9.60	9.60	9.60	9.60
60,000	10.20	8.97	8.97	8.97	8.97	8.97
70,000	9.67	8.20	7.96	7.96	7.96	7.96
80,000	10.68	8.86	8.30	7.60	7.39	7.39
90,000	7.75	6.84	6.84	6.84	6.84	6.84
100,000	7.70	6.69	6.49	6.49	6.49	6.49
110,000	7.69	6.69	6.36	6.21	6.21	6.21
120,000	7.77	6.75	6.42	6.05	6.05	6.05
135,000	7.94	6.89	6.55	6.10	5.84	5.84
150,000	7.83	6.76	6.42	5.97	5.59	5.43
165,000	8.11	6.97	6.61	6.14	5.75	5.51
175,000	8.04	6.90	6.53	6.06	5.66	5.43
Most Likely Average Cost	7.81	6.84	6.59	6.26	5.83	5.51

Table 7-9, cont'd

Channel Depth	45 feet	50 feet	52 feet	55 feet	58 feet	60 feet
DWT, Africa and North Sea						
50,000	23.00	21.36	21.36	21.36	21.36	21.36
60,000	22.81	19.97	19.97	19.97	19.97	19.97
70,000	21.65	18.22	17.66	17.66	17.66	17.66
80,000	23.87	19.62	18.32	16.68	16.20	16.20
90,000	17.21	15.11	15.11	15.11	15.11	15.11
100,000	17.06	14.72	14.25	14.25	14.25	14.25
110,000	16.97	14.63	13.87	13.52	13.52	13.52
120,000	17.14	14.77	14.00	13.12	13.12	13.12
135,000	17.37	14.93	14.14	13.12	12.51	12.51
150,000	17.15	14.67	13.88	12.85	11.96	11.59
165,000	17.75	15.11	14.27	13.18	12.25	11.71
175,000	17.69	15.04	14.20	13.11	12.18	11.64
Most Likely Average Cost	17.37	14.95	14.31	13.44	12.52	11.86
Middle East						
50,000	38.25	35.48	35.48	35.48	35.48	35.48
60,000	37.96	33.18	33.18	33.18	33.18	33.18
70,000	36.04	30.25	29.32	29.32	29.32	29.32
80,000	39.71	32.54	30.36	27.60	26.79	26.79
90,000	28.58	25.03	25.03	25.03	25.03	25.03
100,000	28.30	24.35	23.56	23.56	23.56	23.56
110,000	28.11	24.16	22.89	22.30	22.30	22.30
120,000	28.39	24.40	23.10	21.62	21.62	21.62
135,000	28.69	24.59	23.26	21.54	20.52	20.52
150,000	28.35	24.18	22.84	21.10	19.62	19.00
165,000	29.31	24.87	23.46	21.63	20.07	19.15
175,000	29.28	24.82	23.41	21.57	20.01	19.09
Most Likely Average Cost	28.78	24.85	23.89	22.47	20.61	19.25

Table 7-10
Freeport Crude Petroleum Imports Lightened Cost Per Ton by Channel Depth and Trade Route

	Channel Depth (feet) and Vessel DWT for West Africa, North Sea, and Middle East Cargo					
Mother Vessels (DWT)	**45 feet**	**50 feet**	**52 feet**	**55 feet**	**58 feet**	**60 feet**
Minimum	150,000	150,000	150,000	150,000	150,000	150,000
Maximum	175,000	175,000	175,000	175,000	175,000	175,000
Shuttle Vessels (DWT)						
Minimum	60,000	35,000	35,000	40,000	14,000	0
Maximum	60,000	60,000	50,000	60,000	14,000	14,000
West Africa and North Sea	Per Ton Transportation Cost/Ton to Freeport					
Minimum Lightening Cost	12.43	12.43	12.39	12.25	12.12	11.64
Most Likely Lightening Cost	12.89	12.84	12.76	12.62	12.48	12.02
Maximum Lightening Cost	13.39	13.20	13.11	12.96	12.84	12.40
Middle East	Per Ton Transportation Cost/Ton to Freeport					
Minimum Lightening Cost	19.38	19.38	19.34	19.20	19.07	18.98
Most Likely Lightening Cost	20.05	20.00	19.91	19.77	19.63	19.18
Maximum Lightening Cost	20.79	20.60	20.51	20.36	20.24	19.52

Table 7-11
Freeport Crude Petroleum Imports Lightering Cost Per Ton by Channel Depth and Trade Route

Cost by Channel Depth (feet)	45 feet	50 feet	52 feet	55 feet	58 feet	60 feet
West Africa and North Sea						
Minimum Lightering Cost	11.86	11.62	11.59	11.59	11.59	11.16
Most Likely Lightering Cost	12.12	11.96	11.94	11.76	11.76	11.75
Maximum Lightering Cost	13.44	13.44	13.44	13.44	13.44	13.44
Middle East						
Minimum Lightering Cost	21.16	20.93	20.89	20.89	20.89	20.47
Most Likely Lightering Cost	21.43	21.27	21.25	21.07	21.07	21.06
Maximum Lightering Cost	22.75	22.75	22.75	22.75	22.75	22.75

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 7-12 summarizes the transportation cost by trade route used for the with- and without-project future 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.

Table 7-12
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 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. 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.

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 without- and with-project condition offshore transfer costs. 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.

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 7-13 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 without-project future percentage was assumed to be approximately the same as existing conditions. The with-project future benefit calculations are based on approximately 94 percent of tonnage loaded to 40 feet or more.

Table 7-13
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	With Project Future 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.

Table 7-14 summarizes the annual transportation savings benefits for crude petroleum import tonnage.

Table 7-14
Freeport Crude Petroleum Imports Benefits ($1,000)

Reach 1	**50 feet**	**52 feet**	**55 feet**	**58 feet**	**60 feet**
2017	10,031	13,027	18,296	23,298	35,585
2027	14,211	18,444	25,844	32,911	49,825
2037	17,855	23,174	32,472	41,352	62,604
2047	22,027	28,580	40,003	50,933	76,781
2057	25,987	33,716	47,179	60,070	90,467
2067	29,948	38,852	54,354	69,206	104,152
Average Annual Savings (4.0%)	16,767	21,760	30,486	38,819	58,728
Reach 2	**46 feet**	**47 feet**	**48 feet**	**49 feet**	**50 feet**
2017	279	578	852	1,127	1,368
2027	395	819	1,207	1,597	1,938
2037	496	1,029	1,517	2,006	2,435
2047	613	1,270	1,872	2,476	3,004
2057	723	1,498	2,208	2,921	3,544
2067	833	1,726	2,545	3,366	4,084
Average Annual Savings (4.0%)	466	966	1,424	1,884	2,286

7.1.2 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 the without-project and with-project conditions. As with crude petroleum, transportation costs and savings for product carriers were calculated for vessels that minimize transportation costs given trade route constraints. Long-term fleet selection will continue to reflect goals of minimizing vessel operating costs.

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-foot 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 these shipments ranged from 49 to 54 feet. Table 7-15 shows the percentage of petroleum product imports expected to utilize greater drafts as a result of the cost calculations.

Table 7-15
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
47	n/a	n/a	43	63
48	n/a	n/a	43	63
50	n/a	n/a	43	63

[a]2003–2007 average.

Table 7-16 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 without- and with-project futures.

Table 7-16
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

7.1.3 Chemical Product Exports 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 draft 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 with 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 7-17 shows the percentage of chemical product export tonnage used in the analysis. The without-project future percentage was assumed to be approximately the same as existing conditions. The with-project future percentage is representative of the maximum historical percentage transported at loaded drafts approaching the authorized channel depth.

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 7-17
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.

Table 7-18 summarizes the annual transportation savings benefits for chemical export tonnage.

Table 7-18
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

The transportation costs for chemical products were calculated based on vessels from 50,000 to 65,000 DWT for the existing condition and the without-project future. The with-project future 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.

7.1.4 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 was 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.

According to IWR, Houston data show the average TEU is 9.11 short tons and generally ranges between 8.80 and 10.50 by geographic region. The share of empty containers is approximately 23.9 percent, and the share of vacant slots on containerships is 6.6 percent. These figures were used as base assumptions in the economic model.

Table 7-19 to Table 7-24 show the transportation cost per ton and associated benefits by channel depth by region for imports and exports of containers. Table 7-25 aggregates these regions to show the average annual benefits by channel depth for container trade at Freeport.

Table 7-19
Containers Transportation Cost Per Ton (Mediterranean, Asia Imports)

DWT	40 feet	42 feet	45 feet	48 feet	50 feet
12,000	70.30	70.30	70.30	70.30	70.30
18,000	66.00	66.00	66.00	66.00	66.00
24,000	65.29	65.29	65.29	65.29	65.29
34,000	70.23	70.26	70.26	70.26	70.26
45,000	68.42	68.50	68.55	68.55	68.55
57,000	48.91	46.89	46.93	46.93	46.93
65,000	44.32	40.48	39.51	39.51	39.51
74,000	55.56	49.44	42.43	38.44	38.44
86,000	91.00	80.84	69.26	62.32	62.32
104,000	96.48	86.02	74.00	64.95	63.44
Weighted Cost Per Ton	60.75	57.40	54.64	52.99	52.90
Savings Per Ton		3.35	6.11	7.76	7.85

Table 7-20
Containers Transportation Cost Per Ton (South and Central America Imports)

DWT	40 feet	42 feet	45 feet	48 feet	50 feet
12,000	17.21	17.21	17.21	17.21	17.21
18,000	23.04	23.04	23.04	23.04	23.04
24,000	15.36	15.36	15.36	15.36	15.36
34,000	12.22	12.23	12.23	12.23	12.23
45,000	13.88	12.72	12.42	12.42	12.42
57,000	14.36	13.18	12.29	12.29	12.29
65,000	41.90	38.41	34.15	33.48	33.48
74,000	52.64	47.12	40.73	35.89	33.24
86,000	68.48	61.17	52.76	46.40	42.94
104,000	58.93	52.81	45.71	40.31	37.38
Weighted Cost Per Ton	22.43	21.34	20.25	19.65	19.34
Savings Per Ton		1.09	2.18	2.78	3.09

Table 7-21
Containers Transportation Cost Per Ton (Europe, Africa Imports)

DWT	40 feet	42 feet	45 feet	48 feet	50 feet
12,000	105.11	105.11	105.11	105.11	105.11
18,000	71.62	71.62	71.62	71.62	71.62
24,000	35.60	35.60	35.60	35.60	35.60
34,000	39.61	39.63	39.63	39.63	39.63
45,000	40.27	40.34	40.39	40.39	40.39
57,000	22.78	21.84	21.88	21.88	21.88
65,000	34.79	31.80	31.08	31.08	31.08
74,000	44.12	39.30	33.78	30.64	30.64
86,000	20.24	18.39	16.28	15.02	15.02
104,000	54.19	48.33	41.60	36.52	35.68
Weighted Cost Per Ton	36.56	34.70	33.26	32.40	32.34
Savings Per Ton		1.86	3.30	4.16	4.22

Table 7-22
Containers Transportation Cost Per Ton (Mediterranean, Asia Exports)

DWT	40 feet	42 feet	45 feet	48 feet	50 feet
12,000	44.06	44.06	44.06	44.06	44.06
18,000	42.64	42.64	42.64	42.64	42.64
24,000	42.54	42.54	42.54	42.54	42.54
34,000	47.53	47.55	47.55	47.55	47.55
45,000	52.60	48.20	47.06	47.06	47.06
57,000	35.76	32.81	30.55	30.55	30.55
65,000	31.53	28.86	25.62	25.07	25.07
74,000	38.94	34.81	30.03	26.42	24.45
86,000	69.27	61.85	53.30	46.84	43.33
104,000	74.30	66.55	57.57	50.74	47.03
Weighted Cost Per Ton	42.96	39.84	36.73	35.15	34.35
Savings Per Ton		3.12	6.23	7.81	8.61

Table 7-23
Containers Transportation Cost Per Ton (South and Central America Exports)

DWT	40 feet	42 feet	45 feet	48 feet	50 feet
12,000	24.29	24.29	24.29	24.29	24.29
18,000	27.93	27.93	27.93	27.93	27.93
24,000	21.04	21.04	21.04	21.04	21.04
34,000	17.11	17.12	17.12	17.12	17.12
45,000	18.70	17.14	16.73	16.73	16.73
57,000	19.04	17.48	16.28	16.28	16.28
65,000	44.50	40.78	36.26	35.54	35.54
74,000	55.70	49.85	43.09	37.97	35.16
86,000	70.60	63.06	54.38	47.83	44.26
104,000	62.70	56.19	48.63	42.88	39.76
Weighted Cost Per Ton	26.14	25.20	24.31	23.84	23.60
Savings Per Ton		0.94	1.83	2.30	2.55

Table 7-24
Containers Transportation Cost Per Ton (Europe, Africa Exports)

DWT	40 feet	42 feet	45 feet	48 feet	50 feet
12,000	118.92	118.92	118.92	118.92	118.92
18,000	85.52	85.52	85.52	85.52	85.52
24,000	52.47	52.47	52.47	52.47	52.47
34,000	53.23	53.26	53.26	53.26	53.26
45,000	52.34	52.41	52.46	52.46	52.46
57,000	35.26	34.32	34.35	34.35	34.35
65,000	47.13	43.06	42.71	42.71	42.71
74,000	59.32	52.82	45.37	41.85	41.85
86,000	37.03	33.29	29.03	26.88	26.88
104,000	69.57	62.02	53.36	46.83	46.55
Weighted Cost Per Ton	53.21	50.27	47.92	46.62	46.60
Savings Per Ton		2.94	5.29	6.59	6.61

Table 7-25
Freeport Container Import and Export Benefits ($1,000s)

Year	41 feet	45 feet	46 feet	48 feet	50 feet
2017	504	4,764	5,695	6,903	7,336
2027	543	5,137	6,142	7,444	7,911
2037	543	5,137	6,142	7,444	7,911
2047	543	5,137	6,142	7,444	7,911
2057	543	5,137	6,142	7,444	7,911
2067	543	5,137	6,142	7,444	7,911
Average Annual Savings (4.0%)	535	5,055	6,044	7,444	7,784

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

Table 7-26 displays the average annual benefits by channel depth for vessels using the Upper Stauffer Channel.

Table 7-26
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

7.2 SENSITIVITY ANALYSIS

This section provides sensitivity analyses. Effects of construction cost contingencies, growth forecasts, share of tonnage applied to benefits, variations to container fleet, and sensitivities on many of the assumptions used in the model were analyzed to recognize variables causing the greatest risk and uncertainty and the magnitude of those unknowns. Based on historical trends, regional factors, and well-respected experts in the field, every effort was made to use the most likely assumptions for the with-project condition. The most likely or historical average figures were used in much of the model, but fluctuations from the most likely scenarios will occur because of market conditions and global economies. The sensitivities aim to capture the potential range of uncertainty in the model.

7.2.1 Reduced Construction Cost Contingencies

The effect of lower construction cost contingencies on plan optimization is addressed in this section. Table 7-27 displays the project construction cost by construction contract. In accordance with economic analysis procedures, all of the calculations were performed using economic costs that reflect the inclusion of cost contingencies. The base cost is the cost without the contingency factored into the cost. The total cost includes the contingency and is used as the construction cost for BCR calculations. The low and high show the effects on cost if the percent contingency is reduced by 5 percent and if the percent contingency is increased by 20 percent. The National Economic Development (NED) plan is the alternative with the highest net excess benefits. Net excess benefits is the difference between average annual benefits and average annual costs. The Locally Preferred Plan (LPP) is the alternative that the non-Federal sponsor prefers.

Table 7-27
Construction Cost by Contract for NED and LPP

Contract	Contract Description	Base Cost	Contingency (%)	Total Cost Including Contingency	Low (-5%)	High (+20%)
NED Project Construction Cost ($1,000)						
1	New Extension & Part of Outer	90,058	24	111,672	107,169	129,684
2	Remaining Outer Bar & Jetty	106,317	24	131,833	126,517	153,096
3	Lower Turning Basin	14,801	24	18,345	17,613	21,313
4	Placement Area Jetty Grouting	490	10	540	515	637
5	Dredge to Brazosport to Brazosport Turning Basin	53,880	24	66,806	64,117	77,587
6	Dredge to Upper Turning Basin	36,433	24	45,064	43,355	52,464
7	Lower Stauffer	10,205	24	12,664	12,144	14,695
7	Upper Stauffer	3,294	24	4,090	3,920	4,743
8	Mitigation	211	24	262	251	304
	Total Cost with IDC			419,909	403,087	487,785
LPP Project Construction Cost ($1,000)						
1	New Extension & Part of Outer	50,124	24	62,154	59,648	72,179
2	Remaining Outer Bar & Jetty	80,751	24	100,131	96,094	116,281
3	Lower Turning Basin	13,086	24	16,218	15,572	18,844
4	Placement Area Jetty Grouting	490	10	540	515	637
5	Dredge to Brazosport to Brazosport Turning Basin	43,512	24	53,950	51,779	62,657
6	Dredge to Upper Turning Basin	33,747	24	41,733	40,159	48,596
7	Lower Stauffer	9,540	24	11,840	11,353	13,738
7	Upper Stauffer	3,079	24	3,823	3,664	4,434
8	Mitigation	211	24	262	251	304
	Total Cost with IDC			310,066	297,564	360,092

The table shows a range of construction costs for the NED of about $84 million ranging from $403 million to $488 million with the most likely at $420 million, and for the LPP of about $62 million ranging from $298 million to $360 million with the most likely at $310 million.

7.2.2 Lower and Higher Growth Forecasts

Table 7-28 displays the base tonnage forecasts and the low and high ranges associated with each commodity group to represent the range of scenarios. The low value for the crude petroleum import forecast was based on the AEO low forecast. The high value for the crude petroleum import forecast was based on a trendline of 80 years of historical data for U.S. crude oil imports correlated with historical GDP and Global Insight's forecasted GDP. The low and high values for the petroleum product forecast are based on the base year. The low and high values for the chemical export forecast are based on application of the residual values associated with the trendline equation used to prepare the base forecast.

Table 7-28
Crude Petroleum, Petroleum Product, and Chemical Tonnage Forecasts
Comparison of Base, Low, and High Ranges (Short Tons)

Crude Oil Forecasts (Based on Regression Using Global Insight September 2010 Projections with Freeport Imports as a function of U.S. Imports)							
	2007/2009	**2017**	**2027**	**2037**	**2047**	**2057**	**2067**
base	19,516,000	19,516,000	25,076,000	34,994,000	43,969,000	53,971,000	73,153,000
low	19,516,000	18,806,000	14,153,000	14,464,000	13,831,000	12,573,000	11,316,000
high	19,516,000	38,439,000	61,892,000	99,454,000	120,440,000	147,996,000	175,552,000
Petroleum Product Import Forecast (Application of AEO2010 Product Import Forecast)							
	2007/2009	**2017**	**2027**	**2037**	**2047**	**2057**	**2067**
base	740,000	1,151,000	1,106,000	1,141,000	1,216,000	1,287,000	1,359,000
low	740,000	254,000	244,000	252,000	269,000	284,000	300,000
high	740,000	1,266,000	1,217,000	1,255,000	1,338,000	1,416,000	1,495,000
Chemical Product Export Forecast (Trendline Application)							
	2007/2009	**2017**	**2027**	**2037**	**2047**	**2057**	**2067**
base	2,412,000	3,326,000	4,209,000	5,092,000	5,975,000	6,858,000	7,741,000
low	2,412,000	1,974,000	2,498,000	3,023,000	3,547,000	4,071,000	4,595,000
high	2,412,000	4,678,000	5,920,000	7,162,000	8,403,000	9,645,000	10,887,000
Container Import and Export Forecast (TEUs)							
	2007/2009	**2017**	**2027**	**2037**	**2047**	**2057**	**2067**
base	168,000	217,000	234,000	234,000	234,000	234,000	234,000
low	168,000	168,000	168,000	168,000	168,000	168,000	168,000
high	168,000	234,000	234,000	234,000	234,000	234,000	234,000

Table 7-29 shows the benefits for the low and high growth scenario. The benefits increase in both the low and high scenarios to 60, 50, and 50 feet, respectively, for reaches 1, 2, and 3. These depths also provide the highest BCR, although in the low scenario, the BCR for Reach 1 and Reach 2 fall below unity. Hence, the risk for this sensitivity is mostly associated with the BCR rather than selection of optimal channel depths.

Table 7-29
Low and High Average Annual Benefits for Reach 1, Reach 2, and Reach 3 ($1,000s)

Reach 1	**50 feet**	**52 feet**	**55 feet**	**58 feet**	**60 feet**
Low	6,978	8,998	12,393	15,480	22,704
B/C Ratio	0.5	0.5	0.6	0.7	0.9
High	36,505	47,236	65,666	82,902	123,672
B/C Ratio	2.6	2.9	3.3	3.5	4.7
Reach 2	**46 feet**	**47 feet**	**48 feet**	**49 feet**	**50 feet**
Low	266	537	787	1,031	1,238
B/C Ratio	0.1	0.2	0.2	0.3	0.3
High	1,439	2,912	4,268	5,599	6,730
B/C Ratio	0.4	0.8	1.2	1.5	1.8
Reach 3	**41 feet**	**45 feet**	**46 feet**	**48 feet**	**50 feet**
Low	390	3,688	4,409	5,344	5,679
B/C Ratio	0.3	2.4	2.9	3.4	3.5
High	543	5,137	6,142	7,444	7,911
B/C Ratio	0.4	3.4	4.0	4.7	4.9

7.2.3 Lower and Higher Share of Constrained Tonnages

The purpose of this sensitivity is to evaluate the effect of a lower and higher percentage of crude petroleum being loaded to drafts approaching the without- and with-project future channel depth constraint.

Table 7-30 displays the results of the sensitivity of using a lower (90%) and higher (100%) percentage of crude petroleum tonnage constrained by draft, or in other words, the percent of crude petroleum tonnage applied towards the benefits in the analysis. The results show that average annual benefits for Reach 1 and Reach 2 are affected approximately 4 percent and the BCR remains above unity. The 60-foot-depth for Reach 1 and the 50-foot depth for Reach 2 continue to have the highest BCRs, thereby showing little risk in channel depth selection for each reach.

Table 7-30
Crude Petroleum Imports Average Annual Benefits ($1,000s)
Adjusting Share of Constrained Tonnage

Reach 1	**50 feet**	**52 feet**	**55 feet**	**58 feet**	**60 feet**
Low	17,584	22,721	31,470	39,565	58,626
B/C Ratio	1.2	1.4	1.6	1.7	2.2
High	19,367	25,036	34,713	43,694	64,873
B/C Ratio	1.4	1.5	1.8	1.8	2.1
Reach 2	**46 feet**	**47 feet**	**48 feet**	**49 feet**	**50 feet**
Low	886	1,773	2,591	3,385	4,048
B/C Ratio	0.3	0.5	0.7	0.9	1.1
High	936	1,875	2,742	3,585	4,292
B/C Ratio	0.3	0.5	0.8	1.0	1.2

7.2.4 Variations to Container Fleet

Two sensitivities were conducted for the selection of container fleet. Table 7-31 displays the container benefits based on a U.S. fleet distribution adjusted to exclude vessels over 65,000 DWT.

Table 7-31
Container Import and Export Benefits ($1,000s)
Vessel Fleet Distribution Sensitivity No. 1: Based on U.S. Trip Distribution
(Excluding Vessels over 65,000 DWT)

Year	**41 feet**	**45 feet**	**46 feet**	**48 feet**	**50 feet**
2017	10	42	42	42	42
2027	10	45	45	45	45
2037	10	45	45	45	45
2047	10	45	45	45	45
2057	10	45	45	45	45
2067	10	45	45	45	45
Average Annual Savings (4.0%)	10	44	44	44	44
B/C Ratio (Reach 3)	0.0	0.0	0.0	0.0	0.0

The second sensitivity is based on the Houston tonnage with a maximum-sized vessel of 57,000 DWT. The 18,000 DWT group is calculated using Houston data, plus one-half of the percentage associated with the 24,000 DWT group. The percentage of tonnage for the 24,000 DWT vessels is calculated based on the inclusion of one-half of the smaller class of 24,000 DWT and one-half of the 34,000 DWT group. The percentage of tonnage for the 34,000 DWT group is assumed to be the same as Houston. Freeport's percentage of tonnage for the 45,000 DWT group is assumed to be one-half of Houston's percentage. Freeport's remaining percent is assumed to be transported by vessels represented by the 57,000 DWT group. Table 7-32 shows the container benefits based on Houston distribution disaggregated by region for imports and exports capping at 57,000 DWT. In both sensitivities, the BCR falls below unity for all channel depths, indicating that the BCR for the Lower Stauffer Channel is highly sensitive to assumptions made about fleet selection of containers.

Table 7-32
Container Import and Export Benefits ($1,000s)
Vessel Fleet Distribution Sensitivity No. 2:
Based on Houston Step Share Distribution
(Excluding Vessels over 57,000 DWT)

Year	41 feet	45 feet	46 feet	48 feet	50 feet
2017	301	1,096	1,096	1,096	1,096
2027	325	1,182	1,182	1,182	1,182
2037	325	1,182	1,182	1,182	1,182
2047	325	1,182	1,182	1,182	1,182
2057	325	1,182	1,182	1,182	1,182
2067	325	1,182	1,182	1,182	1,182
Average Annual Savings (4.0%)	320	1,163	1,163	1,163	1,163
B/C Ratio (Reach 3)	0.2	0.8	0.8	0.7	0.7

7.2.5 Other Sensitivity Analyses

Table 7-33 lists the low and high ranges of sensitivities as well as the BCR and its change from the most likely condition by reach. A '-' indicates no statistical change from the most likely condition. As the table shows, the sensitivities that have the potential to lower the BCR below unity for a particular reach have to do with the growth forecasts, the share of crude being imported to Seaway/TEPPCO docks, or the container fleet forecast being representative of the U.S. fleet with a maximum-sized vessel of 65,000 DWT. The AEO low forecast lowers the BCR for Reach 1 and Reach 2 below unity. The petroleum products low forecast lowers the BCR below unity for Reach 2. The U.S. container fleet lowers the BCR for Reach 3 below unity. However, when only one sensitivity is adjusted at a time, the overall project BCR still remains above unity in all scenarios, ceterus paribus.

Table 7-33
Other Sensitivity Analyses

LPP	Range		LPP B/C Ratio in Reaches					LPP % Change in B/C Ratio in Reaches				
Sensitivity	**Low/ High**	**Value**	**All**	**1**	**2**	**3**	**4**	**All**	**1**	**2**	**3**	**4**
Cost Contingency	Low	-5%	1.95	1.70	1.24	5.00	6.66	2	2	2	1	3
	High	20%	1.74	1.52	1.10	4.66	5.70	-9	-9	-9	-5	-12
Underkeel Clearance	Low	2.5	1.76	1.56	1.11	4.30	-	-7	-6	-8	-13	-
	High	4	2.10	1.78	1.30	6.28	-	10	7	8	28	-
Hours to Lightering Zone	Low	7	1.89	1.65	1.20	-	-	-1	-1	-1	-	-
	High	9	1.91	1.68	1.22	-	-	1	1	1	-	-
Hours to Discharge for Lightering-Mother Vessel	Low	10	-	-	-	-	-	-	-	-	-	-
	High	136	1.92	1.68	1.22	-	-	1	1	1	-	-
Port Time	Low	20	-	-	-	-	-	-	-	-	-	-
	High	30	1.92	1.68	1.22	-	-	1	1	1	-	-
Hours Gauging, Setup	Low	3	1.89	1.65	-	-	-	-1	-1	-	-	-
	High	5	-	-	-	-	-	-	-	-	-	-
Hours Downtime of Mother Vessel-Lightening	Low	30	-	-	-	-	-	-	-	-	-	-
	High	60	-	-	-	-	-	-	-	-	-	-
Hours Downtime of Mother Vessel-Lightering	Low	50	1.88	1.64	1.20	-	-	-1	-1	-1	-	-
	High	90	1.91	1.68	-	-	-	1	1	-	-	-
Hours to Discharge for Lightening-Shuttle Vessel	Low	4	-	-	-	-	-	-	-	-	-	-
	High	12	-	-	-	-	-	-	-	-	-	-
Hours to Discharge for Lightering-Shuttle Vessel	Low	4	-	-	-	-	-	-	-	-	-	-
	High	10	-	-	-	-	-	-	-	-	-	-
Hours Downtime of Shuttle Vessel-Lightening	Low	8	-	1.65	-	-	-	-	-1	-	-	-
	High	24	1.93	1.70	1.23	-	-	2	2	2	-	-
Hours Downtime of Shuttle Vessel-Lightering	Low	8	-	-	-	-	-	-	-	-	-	-
	High	16	-	1.67	-	-	-	-	1	-	-	-
Share of Mideast/Far East Oil from Far East	Low	1	-	-	-	-	-	-	-	-	-	-
	High	14	-	-	-	-	-	-	-	-	-	-
% Tonnage Utilization-Mexico	Low	90	-	1.65	-	-	-	-	-1	-	-	-
	High	100	1.91	1.68	1.21	-	-	1	1	1	-	-
% Tonnage Utilization-South America	Low	90	1.88	1.63	1.19	-	-	-1	-2	-1	-	-
	High	100	1.94	1.71	1.23	-	-	2	3	2	-	-

Table 7-33, cont'd

LPP	Range		LPP B/C Ratio in Reaches					LPP % Change in B/C Ratio in Reaches				
Sensitivity	**Low/ High**	**Value**	**All**	**1**	**2**	**3**	**4**	**All**	**1**	**2**	**3**	**4**
% Tonnage Utilization-Mideast and Far East	Low	90	1.89	1.65	1.20	-	-	-1	-1	-1	-	-
	High	100	1.92	1.69	1.22	-	-	1	1	1	-	-
% Tonnage Utilization-Africa and Europe	Low	90	1.89	1.65	-	-	-	-1	-1	-	-	-
	High	100	1.91	1.68	-	-	-	1	1	-	-	-
Freeport Market % Share increase to US crude imports	Low	.03	1.53	1.22	1.02	-	-	-20	-26	-16	-	-
	High	.15	2.02	1.81	1.27	-	-	6	9	5	-	-
% Crude Oil Imported to Seaway/TEPPCO dock	Low	75	1.82	1.43	1.93	-	-	-4	-14	60	-	-
	High	95	1.94	1.79	0.82	-	-	2	7	-32	-	-
% Cost Differential Preference Lightening to Lightering	Low	0	-	-	-	-	-	-	-	-	-	-
	High	5	-	-	-	-	-	-	-	-	-	-
% Cost Differential Preference of Direct Shipment	Low	0	-	-	-	-	-	-	-	-	-	-
	High	5	-	-	-	-	-	-	-	-	-	-
Crude Tonnage Forecast	Low	AEO	1.25	0.89	0.88	-	-	-34	-46	-27	-	-
	High	Trend	4.36	4.58	2.46	-	-	130	175	104	-	-
Share of Petroleum Products from South America	Low	5	-	-	1.22	-	-	-	-	1	-	-
	High	20	-	-	1.17	-	-	-	-	-3	-	-
Petro Prod Tonnage Forecast	Low	2009	1.84	-	0.79	-	-	-3	-	-35	-	-
	High	2007 *1.2	-	-	1.26	-	-	-	-	4	-	-
Chemicals Sensitivity	Low	0.5	-	-	-	-	-	-	-	-	-	-
	High	2	-	-	-	-	-	-	-	-	-	-
% Chemicals from South America	Low	25	1.93	1.69	-	-	-	2	1	-	-	-
	High	75	1.87	1.64	-	-	-	-2	-1	-	-	-
Chemicals Tonnage Forecast	Low		1.84	1.62	-	-	-	-3	-3	-	-	-
	High		1.96	1.71	-	-	-	3	3	-	-	-
TEU to Short Tons	Low	7.5	1.84	-	-	4.02	-	-3	-	-	-18	-
	High	11	1.97	-	-	5.95	-	3	-	-	21	-
(Un)Loading rate Containers	Low	273	-	-	-	4.88	-	-	-	-	-1	-
	High	456	-	-	-	-	-	-	-	-	-	-
Hours in Port-Containers	Low	20	1.88	-	-	4.60	-	-1	-	-	-7	-
	High	30	1.93	-	-	5.37	-	1	-	-	9	-

Table 7-33, cont'd

LPP	Range		LPP B/C Ratio in Reaches					LPP % Change in B/C Ratio in Reaches				
Sensitivity	**Low/ High**	**Value**	**All**	**1**	**2**	**3**	**4**	**All**	**1**	**2**	**3**	**4**
Share of Imports	Low	35	-	-	-	4.98	-	-	-	-	1	-
	High	45	-	-	-	4.86	-	-	-	-	-1	-
Share of Cargo Unloaded from Mediterranean, Asia	Low	8	-	-	-	4.81	-	-	-	-	-2	-
	High	Hous ton	-	-	-	-	-	-	-	-	-	-
Share of Cargo Loaded to Mediterranean, Asia	Low	8	1.89	-	-	4.77	-	-1	-	-	-3	-
	High	Hous ton	-	-	-	-	-	-	-	-	-	-
Share of Cargo Unloaded from South and Central America	Low	8	1.89	-	-	4.76	-	-1	-	-	-3	-
	High	Hous ton	-	-	-	-	-	-	-	-	-	-
Share of Cargo Loaded to South and Central America	Low	8	1.88	-	-	4.66	-	-1	-	-	-5	-
	High	Hous ton	-	-	-	-	-	-	-	-	-	-
Share of Cargo Unloaded from Europe, Africa	Low	8	-	-	-	4.83	-	-	-	-	-2	-
	High	Hous ton	-	-	-	-	-	-	-	-	-	-
Share of Cargo Loaded to Europe, Africa	Low	8	1.87	-	-	4.50	-	-1	-	-	-9	-
	High	Hous ton	-	-	-	-	-	-	-	-	-	-
Share of Container Imports from Mediterranean, Asia	Low	35	-	-	-	4.88	-	-	-	-	-1	-
	High	45	-	-	-	5.01	-	-	-	-	2	-
Share of Container Imports from South and Central America	Low	20	-	-	-	-	-	-	-	-	-	-
	High	30	-	-	-	-	-	-	-	-	-	-
Share of Container Exports from Mediterranean, Asia	Low	18	-	-	-	4.87	-	-	-	-	-1	-
	High	30	1.91	-	-	5.11	-	1	-	-	4	-
Share of Container Exports from South and Central America	Low	30	-	-	-	5.04	-	-	-	-	2	-
	High	40	-	-	-	4.81	-	-	-	-	-2	-
Share of Empty Containers-Mediterranean, Asia Imports	Low	9.2	1.96	-	-	5.83	-	3	-	-	18	-
	High	23.9	-	-	-	-	-	-	-	-	-	-
Share of Empty Containers-Mediterranean, Asia Exports	Low	9.2	1.92	-	-	5.30	-	1	-	-	8	-
	High	23.9	-	-	-	-	-	-	-	-	-	-

Table 7-33, cont'd

LPP	Range		LPP B/C Ratio in Reaches					LPP % Change in B/C Ratio in Reaches				
Sensitivity	**Low/ High**	**Value**	**All**	**1**	**2**	**3**	**4**	**All**	**1**	**2**	**3**	**4**
Share of Empty Containers- South and Central America Imports	Low	9.2	-	-	-	5.00	-	-	-	-	2	-
	High	23.9	-	-	-	-	-	-	-	-	-	-
Share of Empty Containers- South and Central America Exports	Low	9.2	1.91	-	-	5.10	-	1	-	-	3	-
	High	23.9	-	-	-	-	-	-	-	-	-	-
Share of Empty Containers- Europe, Africa Imports	Low	9.2	1.93	-	-	5.40	-	2	-	-	10	-
	High	23.9	-	-	-	-	-	-	-	-	-	-
Share of Empty Containers- Europe, Africa Exports	Low	9.2	1.99	-	-	6.33	-	5	-	-	29	-
	High	23.9	-	-	-	-	-	-	-	-	-	-
Weight per TEU- Mediterranean, Asia Imports	Low	8.4	-	-	-	4.78	-	-	-	-	-3	-
	High	9.34	1.91	-	-	5.11	-	1	-	-	4	-
Weight per TEU- Mediterranean, Asia Exports	Low	8.94	1.88	-	-	4.63	-	-1	-	-	-6	-
	High	10.5	-	-	-	-	-	-	-	-	-	-
Weight per TEU- South and Central America Imports	Low	8.94	-	-	-	4.86	-	-	-	-	-1	-
	High	10.5	-	-	-	-	-	-	-	-	-	-
Weight per TEU- South and Central America Exports	Low	8.94	-	-	-	4.80	-	-	-	-	-3	-
	High	10.5	-	-	-	-	-	-	-	-	-	-
Weight per TEU- Europe, Africa Imports	Low	8.4	-	-	-	4.84	-	-	-	-	-2	-
	High	9.34	-	-	-	5.03	-	-	-	-	2	-
Weight per TEU- Europe, Africa Exports	Low	8.27	1.89	-	-	4.76	-	-1	-	-	-3	-
	High	8.94	1.91	-	-	5.11	-	1	-	-	4	-
Fleet Forecast	Low	US-max 65K	1.59	-	-	0.03	-	-16	-	-	-99	-
	High	Houston	-	-	-	-	-	-	-	-	-	-
Share of Vessels with Competitive Advantage to Freeport over Houston	Low	10	1.88	-	-	4.62	-	-1	-	-	-6	-
	High	50	1.96	-	-	5.83	-	3	-	-	18	-
Underkeel Clearance- Upper Stauffer	Low	1	1.89	-	-	-	4.80	-1	-	-	-	-26
	High	3	-	-	-	-	-	-	-	-	-	-

Table 7-33, cont'd

LPP	Range		LPP B/C Ratio in Reaches					LPP % Change in B/C Ratio in Reaches				
Sensitivity	**Low/ High**	**Value**	**All**	**1**	**2**	**3**	**4**	**All**	**1**	**2**	**3**	**4**
Hours to Upper Stauffer Roundtrip	Low	3.5	-	-	-	-	5.64	-	-	-	-	-13
	High	4.5	-	-	-	-	7.25	-	-	-	-	12
Traffic Growth Rate- Upper Stauffer	Low	1	1.89	-	-	-	5.18	-1	-	-	-	-20
	High	3	1.93	-	-	-	9.87	2	-	-	-	53
Months to Construct- Upper Stauffer	Low	1	-	-	-	-	-	-	-	-	-	-
	High	3	-	-	-	-	-	-	-	-	-	-

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8.0 ECONOMIC SUMMARY

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

Table 8-1 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 8-1
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	169,353	194,914	233,255	290,977	329,458
Interest During Construction	12,104	14,443	17,952	23,487	27,178
Total Investment	181,457	209,357	251,207	314,464	356,636
Average Annual Cost	8,447	9,746	11,694	14,638	16,601
Average Annual O&M[a]	5,786	6,679	8,019	9,163	9,903
Total Annual Cost	14,233	16,424	19,713	23,802	26,505
Average Annual Benefits	18,297	23,647	32,767	41,217	61,125
Net Excess Benefits	4,064	7,223	13,054	17,415	34,620
B/C Ratio	1.3	1.4	1.7	1.7	2.3

Table 8-2 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 channel depth provides the highest net excess benefits of the alternatives analyzed. Channel depths over 50 feet are not included since deepening beyond 50 feet would necessitate significant bank stabilization and dock modifications.

Table 8-2
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	40,884	41,929	42,974	44,019	45,064
Interest During Construction	1,179	1,209	1,240	1,270	1,300
Total Investment	42,063	43,138	44,214	45,289	46,364
Average Annual Cost	1,958	2,008	2,058	2,108	2,158
Average Annual O&M	1,397	1,433	1,468	1,504	1,540
Total Annual Cost	3,355	3,441	3,526	3,612	3,698
Average Annual Benefits	906	1,814	2,651	3,465	4,146
Net Excess Benefits	-2,449	-1,627	-875	-147	448
B/C Ratio	0.3	0.5	0.8	1.0	1.1

Table 8-3 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 structural adjustments to the docks in both Reach 2 and Reach 3, thereby causing the marginal costs to exceed marginal benefits.

Table 8-4 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 by USACE economists 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 depth is 25 feet.

Table 8-3
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	10,021	10,608	11,196	12,077	12,664
Interest During Construction	118	125	131	142	149
Total Investment	10,139	10,733	11,327	12,219	12,813
Average Annual Cost	472	500	527	569	596
Average Annual O&M	948	965	982	1,007	1,024
Total Annual Cost	1,420	1,465	1,509	1,576	1,620
Average Annual Benefits	535	2,614	5,055	7,325	7,784
Net Excess Benefits	-886	1,149	3,546	5,749	6,164
B/C Ratio	0.4	1.8	3.3	4.6	4.8

Table 8-4
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	1,718	3,616	4,090	4,622	5,153	5,685	6,217	6,749
Interest During Construction	3	6	6	8	9	9	10	11
Total Investment	1,721	3,622	4,096	4,630	5,162	5,695	6,227	6,760
Average Annual Cost	80	169	191	216	240	265	290	315
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 8-5 shows the NED benefits and the second half shows the LPP benefits. Although net excess benefits maximized at a channel depth of 60 feet for Reach 1, the non-Federal sponsor opted for a depth of 55 feet and preferred slight other modifications to save in construction costs. The average annual benefits and costs are based on the current discount rate of 4.0 percent. Table 8-6 presents the calculations at 7.0 percent.

Table 8-5
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	290,651
Interest During Construction	19,156	139	6	19,301
Total Investment	294,144	11,979	3,829	309,952
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 8-6
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	12,926	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	290,651
Interest During Construction	34,733	245	11	34,989
Total Investment	309,721	12,085	3,834	325,640
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

8.1 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.[14] The current report represents an update from an original report prepared in 2003.

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

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 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 between 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.[15] 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 Corp., ConocoPhillips Terminal, and TEPPCO Seaway Pipeline Company. In addition to its established base of terminals, the without-project future 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

[15] 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 are presented. This report includes the latest annual data available from the USACE NDC.

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 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 8-7 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 8-7
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
ILA/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.

Table 8-8 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.

The effect on jobs and personal income associated with the Upper Stauffer Channel falls under the marine construction and shipyard activity and appears 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. There are 31 jobs associated with marine construction and shipyard activity.

The current job count of 31 is considerably less than in the 1970s and 1980s when a channel operating depth of 30 feet was available.

Table 8-8 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.

Table 8-8
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 8-9 presents the job impacts per 1,000 tons for each commodity moving via the public and private marine terminals. Bagged rice creates the largest number of direct jobs per 1,000 tons, followed by bulk rice and refrigerated containers. 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 job 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

Table 8-9
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.

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.

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.[16] 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.[17]

The Martin Associates report and specific evaluation to the proposed deepening project suggest 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

[16] http://www.thefacts.com/downloads/PORT%20FREEPORT%20FINAL_1.pdf

[17] *The Economic Impact of Port Freeport, 2003*, Martin Associates, August 2004

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 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 jobs per 1,000 tons.

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9.0 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 set back 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 is 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 1 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 is the second largest contributor. Table 9-1 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 9-1
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

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Appendix B

Engineering Appendix

Job No. 044190100

APPENDIX B
ENGINEERING
FREEPORT HARBOR
CHANNEL IMPROVEMENT PROJECT
BRAZORIA COUNTY, TEXAS

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Acronyms and Abbreviations

3D	three-dimensional
AM	Advance Maintenance
ATON	Aids to Navigation
CEDEP	Cost Engineering Dredge Estimating Programs
CHL	Coastal and Hydraulic Laboratory
CSRA	Cost and Schedule Risk Analysis
CU	Consolidated Undrained Triaxial Compression Test
cy	cubic yards
cy/yr	cubic yards per year
DMMP	Dredged Material Management Plan
EM	Engineering Manual
ER	Engineer Regulation
ERDC	Engineer Research and Development Center
ETL	Engineering Technical Letter
fps	feet per second
GIWW	Gulf Intracoastal Waterway
H&H	Hydrology and Hydraulics
HQUSACE	Headquarter, U.S. Army Corps of Engineers
LNG	liquefied natural gas
LOA	length overall (ship)
LPP	Locally Preferred Plan
LTB	Lower Turning Basin
mg/l	milligram per liter
MLLW	mean lower low water
MLT	mean low tide
NAD	North American Datum
NAVD	North American Vertical Datum
NED	National Economic Development
NGVD	National Geodetic Vertical Datum
NOAA	National Oceanic and Atmospheric Administration
O&M	Operation and Maintenance
ODMDS	Ocean Dredged Material Disposal Site
P&S	Plans and Specifications
PA	placement area
PDT	Project Delivery Team
PED	Preconstruction Engineering and Design
PMP	Project Management Plan

ppt	parts per thousand
SWG	Southwest Division, Galveston District (USACE)
TPCS	Total Project Cost summary
UC	Unconfined Compression Test
USACE	U.S. Army Corps of Engineers
UU	Unconsolidated Undrained Triaxial Compression Test (Q-tests)
VLCC	very large crude carrier

APPENDIX B
ENGINEERING
FREEPORT HARBOR
CHANNEL IMPROVEMENT PROJECT
BRAZORIA COUNTY, TEXAS

1.0 CIVIL ENGINEERING

1.1 INTRODUCTION

The Freeport Harbor Feasibility Study Engineering Appendix follows the requirements of Engineer Regulation (ER) 1110-2-1150, Appendix C. This appendix includes applicable items and information required for the comparative engineering studies, investigations, and design. The specific studies include the ship simulation and shoreline impacts by the U.S. Army Corps of Engineers' (USACE) Engineer Research and Development Center (ERDC). Also, preliminary geotechnical investigations including sampling/analysis and preparation of a preliminary Dredged Material Management Plan (DMMP) were performed. Use of hydrographic surveys, surveying and mapping, environmental quality/mitigation features, preliminary structural design investigations, access roads, operations and maintenance, associated cost estimates, data management, and schedules for design and construction were all considered for development of design features and screening-level cost estimates. These estimates were developed in sufficient detail to substantiate the recommended plan and baseline cost estimate. The first construction contract will consist of hopper dredging of the channel. The design features presented in this appendix provide the basis for the plans and specifications that will be prepared later during Preconstruction Engineering and Design (PED).

The Design Team assisted the Planner and Environmental Lead during the Plan Formulation process. This includes Planning Objectives and Preliminary Plan Formulation consisting of the No-Action Alternative and Action Plan alternatives pertaining to navigation improvements. Engineering work during Detailed Plan Formulation consisted of evaluating alternatives advanced for further screening as detailed in the Feasibility Report. The study generated a National Economic Development (NED) plan and a Locally Preferred Plan (LPP); both are defined as:

The NED Alternative is referred to as the 60-foot by 540-foot project because the width of the Jetty Channel would be restricted to 540 feet. This alternative proposes to extend the Outer Bar Channel (Channel Extension) 3.2 miles farther into the Gulf of Mexico at a depth of 62 feet and a width of 600 feet, deepen the existing Outer Bar Channel to 62 feet and the Jetty Channel to 60 feet, deepen the main channel from the Lower Turning Basin through Station 132+66 (just above the Brazosport Turning Basin) to 60 feet and widen the Brazosport Turning Basin to 1,200 feet, deepen the main channel from Station 132+66 through the Upper Turning Basin to 50 feet, *deepen and widen the Lower Stauffer Channel to 50 feet by 300 feet, and dredge the Upper Stauffer Channel to 25 feet deep by 200 feet wide in lieu of restoring its previous dimensions of 30 feet by 200 feet.*

The LPP Alternative is referred to as the 55-foot by 600-foot project. This alternative proposes to extend the Outer Bar Channel (Channel Extension) 1.3 miles farther into the Gulf of Mexico at a depth of 57 feet and a width of 600 feet, deepen the existing Outer Bar Channel to 57 feet and the Jetty Channel to 55 feet, deepen the main channel from the Lower Turning Basin through Station 132+66 (just above the Brazosport Turning Basin) to 55 feet and widen the Brazosport Turning Basin to 1,200 feet, deepen the main channel from Station 132+66 through the Upper Turning Basin to 50 feet, deepen and widen the Lower Stauffer Channel to 50 feet by 300 feet wide, and dredge the Upper Stauffer Channel to 25 feet deep by 200 feet wide in lieu of restoring its previous dimensions of 30 feet by 200 feet.

This section on civil design focuses primarily on analysis of existing cross-section surveys, proposed channel templates, and geometric design for proposed channel deepening and widening alternatives. Considerations consisted of conceptual assumptions to navigation channel realignment, proposed new work, maintenance dredging requirements, and placement plan for dredged material as needed to establish feasibility-level cost estimates. The design tables and preliminary CADD study plates incorporated are in sufficient detail to provide the basis for the plans and specifications that will be prepared later during the PED phase.

The objectives of civil design were to present the design rationale for the proposed plans (i.e., NED Plan and LPP); develop the project, plan new work volumes and 50-year maintenance dredging requirements, identify the extent of removals and relocations, identify potential impacts to existing infrastructure and environmentally sensitive areas, and determine real estate requirements as needed. The analysis began using the existing channel template configuration as a basis to derive different improved channel alignments, dredge toes, and templates (i.e., depths, widths, and side slopes). In evaluating and assessing the technical practicality of several different channel improvement alternatives and design features, items such as the existing and future-planned facilities; existing pipelines, utilities, and structures; disposal requirements for dredged material; and real estate requirements were considered for the feasibility study. Civil design focused on conceptually functional design requirements such as dredge limit layout, performance, and placement plan footprints. Cost Engineering was provided resulting data, in the form of new work quantity tables for estimating the initial construction for a technically feasible improved channel. The preliminary costs were contrasted against potential future benefits (see Economics Appendix) derived from the conceptual improvement alternatives. This process basically yielded competing Benefit-Cost Ratios and is further discussed in the Feasibility Report. The channel that yielded the maximum net excess benefits became the NED Plan due to Federal project requirements.

The site selection and project development consisted of three distinct phase systems: Initial Plan Formulation, Plan Formulation, and Detail Design. The Initial Plan Formulation and Plan Formulation phases included gathering site data and validating data pertaining to existing conditions. The Detail Design phase consisted of assessing problems with the proposed channel reconfigurations and making a learned recommendation based on analytical findings to yield the NED Plan and the LPP.

1.2 DREDGING TERMS

The term "new work" refers to the material below the existing channel template that is needed to be removed in order to increase to the new project depth. The new work material quantities were calculated using an overall surface of x,y,z coordinate data points referred to as a digital terrain model or dtm file, generated by the MicroStation CADD Bentley InRoads software program. The surface is a three-dimensional (3D) representation of the existing channel conditions of various survey mergers taken between 2003 and 2006. Each channel configuration had its own existing template and proposed template. The template is a trapezoidal shape, defined by bottom width and side slopes. A model was developed and volumes were computed. These design analyses are documented each time a run is updated in CADD.

1.2.1 Advance Maintenance

Advance Maintenance (AM) consists of dredging deeper than the authorized channel dimensions so as to provide for the accumulation and storage of sediment. In critical and fast-shoaling areas, it is required to avoid frequent redredging and to ensure the reliability and least overall cost for operating and maintaining the project authorized dimensions. The existing channel has a constant 2-foot AM. During the Detail Design phase, an analysis was performed by the Hydrology and Hydraulics (H&H) section to determine any changes in dredging frequencies based on predicted shoal rates and whether an increase to AM would be required. Based on the H&H analyses, there was no recommendation to increase AM. Therefore, results are assumed to match current conditions.

1.2.2 Allowable Overdepth

An additional depth outside the required template is permitted to allow for inaccuracies in the dredging process. District of commanders may dredge a maximum of 2 feet of allowable overdepth in coastal regions and in inland navigation channels (ER 1130-2-520 *Navigation and Dredging Operations and Maintenance Policies)*. This additional dredging allowance is referred to as a dredging tolerance, or allowable overdepth. The existing channel overdepth from deeper water up to Station 82+66 is 2 feet and was assumed to remain constant for the proposed channel. As the stationing increases upstream beyond Station 82+66, a 1-foot overdepth was assumed to match existing.

1.2.3 Nonpay Dredging

Nonpay dredging is dredging outside the paid allowable overdepth that may occur due to such factors as unanticipated variations in substrate, incidental removal of submerged obstructions, or wind or wave conditions. There are no known conditions that would indicate that the contractor will require extensive dredging in order to cut the proposed channel template. Thus, the new work volumes do not include any estimate of nonpay dredging. New work material volumes can be seen for the NED Plan and the LPP in tables 1 and 2.

Table 1
Freeport New Work Dredging Volumes for 60x540 NED Plan*

Authorized Depth (feet)	Adv. Maint. Shoaling (feet)	Allowable Dredging Pay Tolerance (feet)	Bottom Width (feet)	New Work Section of Waterway (NED 60x540 Plan)	NED Station Start	NED Station End	Required Quantity (cubic yards)	Allowable Quantity (cubic yards)
62	2	2	600	Future Channel Extension	–300+00	–470+00	2,000,000	670,000
62	2	2	600	Outer Bar	0+00	–300+00	7,800,000	1,300,000
60	2	2	540	Jetty Reach	71+52	0+00	2,900,000	287,000
60	2	2	Match existing	Lower Turning Basin	78+52	71+52	280,000	38,000
60	2	1	1,200 turning basin	Channel to Brazosport & New 1,200-foot Brazosport Turning Basin	115+00	78+52	2,200,000	116,000
60	2	1	Match existing	Channel from Brazosport Turning Basin	132+66	115+00	513,000	34,000
50	2	1	Match existing	Channel to Upper Turning Basin & Upper Turning Basin	184+20	132+66	380,000	110,000
50	2	1	300	Stauffer Channel, Lower Reach	222+00	184+20	1,340,000	47,000
25	2	1	200	Stauffer Channel, Upper Reach & Turning Basin	260+00	222+00	390,000	37,000
					Sub-Total		17,803,000	2,639,000
					TOTAL		20,442,000	

*From the Government interests, the action plan evaluated is the NED Plan. This plan is the Federal plan shown in the table and is also referred to as the 60x540 Plan.

1. Required Quantity includes the AM.
2. Overdepth (Allowable Dredging) is an additional 2 feet at Station 82+66 towards deeper water in Gulf of Mexico and is 1 foot going from Station 82+66 up-station to end of Stauffer.
3. Proposed Extension quantities extrapolated using nautical chart contour limits.
4. Stauffer Channel Volume to –20-foot depth is:
   89,000 cubic yards (Sta. 222+00 to 260+00)
   30,000 cubic yards (Sta. 184+20 to 222+00)
5. If costing excavation above water line at Seaway Containment dike, deduct:
   260,000 cubic yards (from volume in reach Sta. 78+52 to 115+00)
6. Existing bottom widths vary and for cost purposes assumed average is 400 feet.

Table 2
Freeport New Work Dredging Volumes for 55x600 LPP*

Authorized Depth (feet)	Adv. Maint. Shoaling (feet)	Allowable Dredging Pay Tolerance (feet)	Bottom Width (feet)	New Work Section of Waterway (LPP 55x600 Plan)	LPP Station Start	LPP Station End	Required Quantity (cubic yards)	Allowable Quantity (cubic yards)
57	2	2	600	Future Channel Extension	–300+00	–370+00	500,000	295,000
57	2	2	600	Outer Bar	0+00	–300+00	4,990,000	1,300,000
55	2	2	600	Jetty Reach	71+52	0+00	3,345,000	303,000
55	2	2	Match existing	Lower Turning Basin (LTB)	78+52	71+52	170,000	38,000
55	2	1	1,200 turning basin	Channel to Brazosport & New 1,200-foot Brazosport Turning Basin	115+00	78+52	1,600,000	116,000
55	2	1	Match existing	Channel from Brazosport Turning Basin	132+66	115+00	357,000	34,000
50	2	1	Match existing	Channel to Upper Turning Basin & Upper Turning Basin	184+20	132+66	380,000	110,000
50	2	1	300	Stauffer Channel, Lower Reach	222+00	184+20	1,340,000	47,000
25	2	1	200	Stauffer Channel, Upper Reach & Turning Basin	260+00	222+00	390,000	37,000
					Sub-Total		12,072,000	2,280,000
					TOTAL		14,352,000	

*The non-Federal sponsor's plan referred to as the LPP is shown in this table and is also referred to as the 55x600 Plan.

1. Required Quantity includes the AM.
2. Overdepth (Allowable Dredging) is an additional 2 feet at Station 82+66 towards deeper water in Gulf of Mexico and is 1 foot going from Station 82+66 up-station to end of Stauffer.
3. Proposed Extension quantities extrapolated using nautical chart contour limits.
4. Stauffer Channel Volume to –20-foot depth is:

   89,000 cubic yards (Sta. 222+00 to 260+00)

   30,000 cubic yards (Sta. 184+20 to 222+00)
5. If costing excavation above water line at Seaway Containment dike, deduct:

   260,000 cubic yards (from volume in reach Sta. 78+52 to 115+00)
6. Existing bottom widths vary and for cost purposes assumed average is 400 feet.

In restating, required quantities column shown in tables 1 and 2 does include the 2-foot AM. Maximum allowable overdepth volume was broken out separately for use by Cost Engineering.

The amounts shown in tables 1 and 2 represent the neat line in situ material volume with a minimal amount of shoal material present that would otherwise be dredged in conjunction with maintaining the existing project channel.

Refer to the Geotechnical portion of this appendix for the characteristics of the material to be encountered as well as the DMMP.

1.2.4 Dredging Frequency

The dredging cycle of a channel is defined by the average number of years between the Operation and Maintenance (O&M) dredging operations for a historical period. Each channel has its own dredging frequency. The USACE, Galveston District's Dredging Histories Database Management System contains this information, and is the major source for the ERDC Sediment Study Report. It is assumed for the new project that the dredging frequency will adjust from the existing channel conditions, and this change is discussed in the H&H desktop shoaling study. Estimated frequency breakout and discussion are provided in the Geotechnical DMMP (Section 4.7, Table 7) and the H&H (Section 2.0, Table 3) sections of this appendix.

1.2.5 Predicted Shoaling Rates

A desktop study for sediment-related problems was performed by ERDC and is presented in Section 2.0 (H&H) of this appendix. The study produced estimates based on entire reaches. An adjustment was performed on the ERDC values to approximate the dredging sections. Refer to Section 2.0 of this appendix for dredge requirements.

The NED Alternative is referred to as the 60-foot by 540-foot project because the width of the Jetty Channel would be restricted to 540 feet. This alternative proposes to extend the Outer Bar Channel (Channel Extension) 3.2 miles farther into the Gulf of Mexico at a depth of 62 feet and a width of 600 feet, deepen the existing Outer Bar Channel to 62 feet and the Jetty Channel to 60 feet, deepen the main channel from the Lower Turning Basin through Station 132+66 (just above the Brazosport Turning Basin) to 60 feet and widen the Brazosport Turning Basin to 1,200 feet, deepen the main channel from Station 132+66 through the Upper Turning Basin to 50 feet, deepen and widen the Lower Stauffer Channel to 50 feet by 300 feet, and dredge the Upper Stauffer Channel to 25 feet deep by 200 feet wide in lieu of restoring its previous dimensions of 30 feet by 200 feet.

The LPP Alternative is referred to as the 55-foot by 600-foot project. This alternative proposes to extend the Outer Bar Channel (Channel Extension) 1.3 miles farther into the Gulf of Mexico at a depth of 57 feet and a width of 600 feet, deepen the existing Outer Bar Channel to 57 feet and the Jetty Channel to 55 feet, deepen the main channel from the Lower Turning Basin through Station 132+66 (just above the Brazosport Turning Basin) to 55 feet and widen the Brazosport Turning Basin to 1,200 feet, deepen the main channel from Station 132+66 through the Upper Turning Basin to 50 feet, deepen and widen the Lower Stauffer Channel to 50 feet by 300 feet wide, and dredge the Upper Stauffer Channel to 25 feet deep by 200 feet wide in lieu of restoring its previous dimensions of 30 feet by 200 feet.

As defined in the global scope above, the required depth project geometric navigation improvements are summarized reach by reach below:

A. Future Channel Extension for LPP (Sta. –300+00 to Sta. –370+00). Should the LPP be selected, this proposed future reach will extend from the present offshore terminus out farther into the Gulf of Mexico until the 59-foot contour is encountered.

B. Future Channel Extension for NED (Sta. –300+00 to Sta. –470+00). Should the NED be selected, this proposed future reach will extend from the present offshore terminus out farther into the Gulf of Mexico until the 62-foot contour is encountered.

C. Outer Bar (Sta. –300+00 to Sta. 0+00). This offshore channel reach under present authorization extends 30,000 feet out into the Gulf of Mexico from its juncture with the Jetty Channel. Vessels in the Entrance Channel are completely exposed to crosscurrents and waves from the open Gulf.

D. Jetty Channel (Sta. 0+00 to Sta. 71+52). This offshore channel reach under present authorization extends 6,346 feet landward from its juncture with the Entrance Channel. Vessels in the Jetty Channel are sheltered from crosscurrents and waves by the jetties.

E. Lower Turning Basin (Sta. 71+52 to Sta. 78+52). This turning basin reach under present authorization is 750 feet in diameter and is located at the intersection of the Gulf Intracoastal Waterway (GIWW) and Freeport Channel adjacent to the future liquefied natural gas (LNG) facility. The proposed plans provide for no change other than deepening as required per LPP or NED.

F. Channel to Brazosport and New 1,200-foot Brazosport Turning Basin (Sta. 78+52 to Sta. 115+00). This reach under present authorization varies in width and extends westward from the intersection of the GIWW and Freeport Channel adjacent to the future LNG facility. New Brazosport Turning Basin. This turning basin reach under present authorization is 1,000 feet in diameter and is located at the terminus of Seaway Terminal adjacent to the GIWW. The proposed plans provide for increasing the footprint to 1,200-foot diameter and associated deepening as required per the LPP or NED Plan.

G. Channel from Brazosport Turning Basin (Sta. 115+00 to Sta. 132+66). This reach under present authorization varies in width from 250 to 400 feet and extends west from the existing Brazosport Turning Basin parallel to the Seaway Terminal. The proposed plans provide for no change other than deepening as required per the LPP or NED Plan.

H. Channel to Upper Turning Basin and Upper Turning Basin (Sta. 132+66 to Sta. 184+20). This reach under present authorization varies in width from 275 to 550 feet and extends west from the existing Brazosport Turning Basin parallel to the Seaway Terminal. The proposed plans provide for no change other than deepening as required per LPP or NED. Upper Turning Basin. This Turning Basin reach under present authorization is 1,200 feet in diameter and is the existing project terminus offset the Brazos Harbor Channel. The proposed plans provide for no change other than deepening as required per LPP or NED.

I. Stauffer Channel, Lower Reach (Sta. 184+20 to Sta. 222+00). This lower existing 200-foot-wide reach adjacent to Dow Chemical under present authorization is deauthorized. The proposed plans provide for reauthorizing and improving the channel reach to 52x300 feet in case of the NED or 52x300 feet in case of the LPP.

J. Stauffer Channel, Upper Reach and Turning Basin (Sta. 222+00 to Sta. 260+00). This upper existing reach, which includes a 500-foot-wide turning basin, is currently deauthorized. The proposed plans provide for reauthorizing and improving the channel reach to 27x200 feet to include a 500-foot-diameter turning basin for the NED or 27x200 feet to include a 500-foot-diameter turning basin for the LPP.

1.3 INITIAL PLAN FORMULATION AND PLAN FORMULATION PHASE

Initial Plan Formulation considered several alternative depths such as 45, 48, 50, 52, 55, 57, 59, 60, and 62 feet. Other considerations included Ship Tracks Navigating the Inland Reaches, Jetty Channel, and Outer Bar Channel and are addressed in Section 2.0 (H&H) of this appendix.

1.3.1 Turning Basins

An improvement to the Brazosport Turning Basin was considered and developed. The existing Brazosport Turning Basin (1,000-foot diameter) shall be enlarged and configured to accommodate a 1,200-foot turning diameter. The other basin to be affected is the currently deauthorized Stauffer Turning Basin (Sta. 259+00 or north end of project). The Stauffer Turning Basin shall be reauthorized to its former 500-foot diameter for the NED Plan or the LPP. The other existing turning basins in the Freeport Channel inland reaches shall remain unchanged.

1.3.2 Channel Geometry

The proposed Extension to the Entrance Channel was determined for the various depths, and the existing channel centerline alignment was adjusted (shifted away from the South Jetty) as required per Geotechnical investigations during the Initial and Planning stage. The problem is the location of the new Entrance and Jetty Channel centerline will be dependent on not only the channel width but also the channel depth. For instance, if the channel is widened from 400 feet to 600 feet and not deepened, the new centerline would be 100 feet northward of the existing channel centerline. If the channel depth is increased by 10 feet (45 to 55 feet) and widened from 400 to 600 feet (the LPP), the new centerline will shift 130 feet northward of the existing channel centerline. If the channel depth is increased by 15 feet (45 to 60 feet) and widened from 400 to 540 feet (NED Plan), the centerline will shift 115 feet northward of the existing channel centerline.

Attached in the drawings at end of this document is the “official” existing alignment and the preliminary LPP and NED Plan centerlines.

1.3.3 Relocations

With respect to the channel pipelines if encountered, the current District policy requirements for an underground pipeline is that it must be located at least 20 feet below the authorized bottom depth of the channel and at least 50 feet from the channel bottom edge, or channel toe above the plane of the prescribed channel bottom.

A total of two pipelines were identified. One known as the Enbridge Offshore PLS Seacrest LP (formerly Tejas Power Corporation) 16-inch pipeline (Permit No. 18902), located at Station 37+60 and a proposed pipeline via LNG Permit action to be installed at required depth near Sta. 65+00 in advance of any future project authorization. The pipeline crossing in the vicinity of Sta. 37+60 appears on USACE permit (#18902 Enbridge 16-inch pipeline). The non-Federal sponsor stated this pipeline was reset at an elevation closer to –92 MLT. At the time of this report, the project team resolved all pipeline depth is sufficient to accommodate channel improvement.

No bridges or electrical towers required relocation.

1.4 DETAIL FORMULATION DESIGN PHASE

This phase concentrates on refinement and development of the selected plans (NED and LPP). The selected plans were identified by the Project Delivery Team (PDT) and are technically defined according to tables 1 and 2 presented earlier in this section. Both tables outline the proposed dimensions and volumes accordingly.

1.4.1 Alignments

The centerline alignments differ slightly from the existing due to the selective widening in the plans (Permit, LPP, or NED). The centerline of the proposed channel will be shifted as this related to the geotechnical stability concerns of the South Jetty. The technical description for the preliminary alignments for the NED and LPP are attached in the drawings that accompany this document. Also attached for reference is the technical description of the existing channel alignment. Final layout will be performed during PED phase.

1.4.2 Bend Easing

Bend easing (transitioning) approaching the Lower Turning Basin is desirable and one reason for adjusting the channel bottom to accommodate the new LNG facility on the Quintana side and a proposed dock on Surfside Beach side. The easing is accomplished by widening landward up to approximately Sta. 45+00 and transitioning the channel footprint down to varying widths as needed on the right side nearing the existing North Jetty shoreline protection adjacent to the U.S. Coast Guard Station. It should be noted that in either the LPP or NED Plan, the North Jetty shoreline protection will be slightly impacted by top of cut in the range of Sta. 40+00 to Sta. 60+00, and therefore a tapered transition is proposed to keep encroachment to a minimum.

1.4.3 Real Estate

Additional land was required for the NED Plan or LPP improvements for long-term disposal purposes. The real estate is required for the 50-year DMMP as called out in Section 4.0 (Geotechnical) of this report. The areas provided are placement areas (PAs) 8 and 9. Further real estate actions to secure rights and actual acreages of all relevant areas are discussed in the Feasibility Report.

The existing open-water ocean dredged material disposal site (ODMDS) can be used provisionally under navigational servitude.

With respect to placement areas, both offshore and upland disposal areas identified on drawings will be utilized for construction of the project. Material removed from the Jetty reach and Outer Bar will be disposed of offshore. For dredging main channel reaches, the two new upland confined PAs (8 and 9) will be containment diked and contain spillways for discharge of effluent. Effluent from the new PAs will be discharged into the Brazos River. The surface area of new PAs 8 and 9 is 168 and 250 acres, respectively.

1.4.4 Mitigation

The term “mitigation” is used to refer to measures that were studied to reduce impacts from the deepening and widening project. Coordination with Cultural Resources and Environmental will occur as required to confirm measures or areas to avoid, minimize, or compensate for negative impacts. Final measures for mitigation are discussed more in the Environmental Impact Statement to this Feasibility Report.

1.4.5 Aids to Navigation

All of the existing aids to navigation (ATON, or “aids”) for the channel will be adjusted as required. However, other aids affected by the plan, such as the reauthorized Stauffer Channel, will need to be evaluated during PED. In addition, new aids will be required in the offshore reach beyond the existing channel limits for the NED Plan or LPP. The proposed Permit Widening Action will take place primarily on the north side of the Outer Bar and Jetty channels, which will result in the centerline of the Entrance Channel shifting to the north in this reach of the channel. The widening will impact existing aids to navigation along the north sides of both the Outer Bar and Jetty channels. Most significantly, the existing entrance range towers will no longer be aligned with the centerline of the widened channel. In order to mark the centerline of the improved channel, the range towers will have to be adjusted to the north and on tangent to the improved channel centerline unless it is decided to maintain an offset centerline.

1.4.6 Access Roads

All existing and proposed placement areas have existing access routes. The new upland Pas are basically configured on non-Federal sponsor–prescribed plats adjacent to the Brazos River and can be reached from existing access roads near these new areas. Additional access to project sites will be by water, with some sites only being accessible through waterborne equipment. No public roads require any improvement for access to the project sites.

1.5 SURVEYING, MAPPING, AND OTHER GEOSPATIAL DATA REQUIREMENTS

1.5.1 Surveys

For this study, survey coverage consists of maintenance cross sections along with non-Federal sponsor–delivered multi-beam condition surveys. The surveys mentioned were utilized to identify principal design features, volume estimates, impacts, and anomalies primarily associated in the vicinity of the Outer Bar and Jetty Channel and Main Channel reaches. The District utilized color orthodigital aerial photographs taken in 1995 to identify existing topographical features such as shoreline, docks, creeks, potential upland PA sites, wooded areas, etc. Additional land elevations were implied from the orthodigital maps. When applicable, interpolation between hydro-surveys and land surveys was performed using the MicroStation Bentley InRoads Civil Design software program once processed survey data were provided. An overall 3D surface or digital terrain model (.dtm) was generated using the software application providing a very good representation of the existing conditions along the Freeport Harbor Channel.

1.5.2 Additional Surveys

Additional surveys in the form of multi-beam were provided by the non-Federal sponsor and deemed useful in developing feasibility design layout in terms of the Jetty Reach. Due to stability concerns of the South Jetty, the surveys gave a clear .dtm in order to investigate various best-fit LPP or NED channel configuration. These surveys were gathered by the non-Federal sponsor with USACE scope coordination and will be further utilized during the PED phase, although it should be noted for contract purposes standard updated hydrographic surveys will be taken. Land surveys will be performed at necessary locations to include anticipated new upland confined PAs and any mitigation measures (features), as required. At this time, no significant mitigation measures have been identified.

1.5.3 Mapping

For this study, existing maps available through the Galveston District of the vicinity were used during the Initial and Plan Formulation phases. This feasibility phase study report only includes plates of an adequacy to define the principal features as detailed in this appendix.

1.5.4 Additional Mapping

The mapping will require only additional updating as time progresses. It is not anticipated that any major changes will occur relating to the mapping presented in this appendix.

1.5.5 Vertical Datum

All elevations referred to in this report, unless specifically noted otherwise, are based on the 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 datums are presented in the studies performed by ERDC, and can be referenced for more clarification.

1.5.6 Horizontal Datum

The North American Datum of 1927 (NAD 27) was used during the Initial and Plan Formulation phases. During Final Plan, 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.

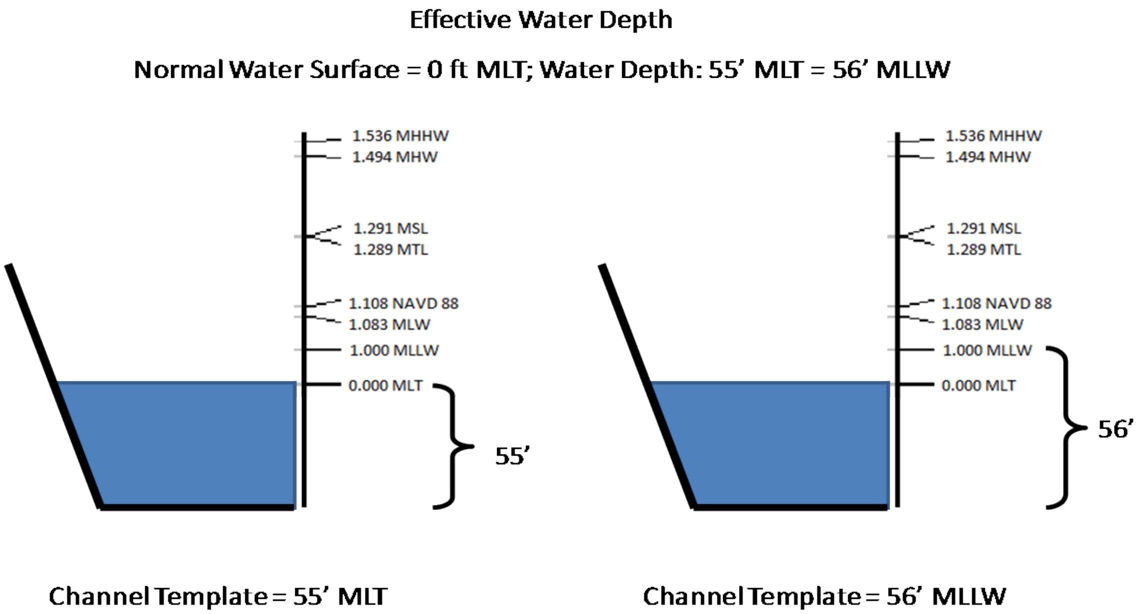
1.5.7 Tidal Datum

Army regulations and Headquarters, USACE (HQUSACE) guidance on tidal datum, provided in Engineering Technical Letter (ETL) 1110-2-349 *REQUIREMENTS AND PROCEDURES FOR REFERENCING COASTAL NAVIGATION PROJECTS TO MEAN LOWER LOW WATER DATUM*, dated 1 April 1993, and Engineering Manual (EM) 1110-2-1003, 1 April 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 (NOAA) and

Coast Guard navigation charts, and to avoid misconceptions within the shipping and dredging industries with regard to channel depths.

1.5.8 Tidal Datum 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 the following figure.



At Freeport Channel, datum values for MLLW are +1 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. As the project moves to PED phase, tidal data references will be documented as MLLW.

2.0 HYDROLOGY AND HYDRAULICS

2.1 MODELING STUDIES

The proposed modification of the Navigation Channel required several studies including field data collection, hydrodynamics, ship simulation, sediment, storm surge, and shoreline impacts. The Coastal and Hydraulics Laboratory (CHL) of USACE ERDC conducted all of these studies, and they are described separately following this section. These reports are:

> Freeport Harbor Field Data Collection Program, Final Report. June 2007. ERDC/CHL (M. Tubman, T.M. Parchure, B. Brown, N. Raphelt, and B. Guay)
>
> Freeport Harbor Ship Simulator Hydrodynamic Study. February 2005. ERDC-CHL (J.V. Letter Jr., W.L. Boyt, B. Brown, C.T. Goodin, and D.M. McVan)
>
> Navigation Study for Freeport, Texas Turning Basin Data Report. August 2010. ERDC-CHL (Dennis W. Webb)
>
> Navigation Study for Port Freeport, Texas. August 2007. ERDC-CHL (T. Shelton)
>
> Desktop Sediment Study for Freeport Project. Draft September 2005. ERDC-CHL (T.M. Parchure, B. Brown, N. Raphelt, L. Vera, and J. Pena)
>
> Evaluation of Improvements to the Freeport, Texas Ship Channel Under Hurricane-Induced Storm Surge Conditions. May 2007. ERDC-CHL (David J. Mark)
>
> Shoreline Impacts Due To Proposed Deepening of Freeport, Texas Entrance Channel. July 2007. ERDC/CHL (David B. King Jr.)

As this section consists of only concise descriptions and summarized conclusions of various modeling projects conducted by ERDC, a reviewer is advised to refer to the original study reports for a detailed description of these studies.

2.2 FIELD DATA COLLECTION

A field data collection program was conducted during the fall of 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.

The work plan included water-level and water-quality measurements for a 24- to 30-day period at four locations, transects of current measurements across the navigation channel, and water-quality measurements, over a spring tidal cycle, and 35 bottom-sediment samples. During collection of the bottom-sediment samples, mid-depth water samples were collected for water-quality measurements.

Tidal characteristics at the water-level recorders did not vary significantly from each other. They were predominantly diurnal with neap tide ranges of 0.8 to 1.5 feet, and spring tidal ranges of 2.5 to 3 feet. There are small oscillations with periods that are roughly 20 times shorter than the diurnal tidal period present at all four locations. These are likely the result of harbor seiching.

There is no specific spatial or temporal trend in suspended sediment concentrations seen in the results of the analyses of the water samples from the automatic water samplers. The concentrations mostly ranged between 10 and 80 milligrams per liter (mg/l) at the three stations in the navigation channel. At the station to the southwest in the GIWW toward the Brazos River, concentrations varied between 50 and 185 mg/l. This was probably due to the samples containing sediment from the river. Nearbed suspension showed some large fluxuations, due to bed sediment entering water samples during collection, or due to instantaneous high resuspension caused by ship and barge traffic. The median diameter of sediment in suspension varied between 46 and 92 micron-size.

Salinities during the program ranged from around 15 parts per thousand (ppt) to around 32 ppt at all locations except those at the GIWW near the Brazos River, where salinities as low as around 5 ppt were measured. The data indicate that the Brazos River is a source of fresh water for the Harbor. In general, mid-depth and bottom salinities stayed within relatively narrow ranges near 30 ppt at all stations, while surface salinities varied significantly over the tidal cycle. Higher salinity from the Gulf of Mexico enters the Harbor through the Entrance Channel.

A 25-hour current transect survey was conducted at four transect locations during spring tide, which was recognized as having the strongest currents. One transect was located in the Entrance Channel, and one was across the inner navigation channel. The other two were in the GIWW, northeast and southwest of the navigation channel. Each transect was surveyed every hour. During these surveys, the flow in the inner navigation channel was very low and within the noise level for the survey. During flood flow, there were significant cross-channel variations in the current along the Entrance Channel and in the northeast GIWW transect. A maximum speed of 3.56 feet per second (fps) toward the Entrance Channel was measured along this transect on the eastern side of the GIWW. Maximum flood flows along the transect in the Entrance Channel were between 2.0 and 2.5 fps, while maximum ebb flows were between 1.0 and 1.5 fps. The tidal currents measured in the Freeport Harbor inner navigation channel are all within the noise level of the survey. The noise can be the result of a combination of rocking of the survey vessel, in response to waves and boat wakes, and harbor seiching at frequencies much higher than that of the tides, as well as turbulence from stirring of the harbor by ships, barges, and even the survey vessel. The noise level appears to be about 0.5 fps, so what is known from the survey is that tidal currents in the Harbor were less than 0.5 fps.

No specific spatial pattern was observed in the suspended sediment results. The salinity results indicate that the Brazos River supplies fresh water to the GIWW, which then gets transported into Freeport Harbor. Higher-salinity water enters the Harbor through the Entrance Channel. The bed in the Navigation Channel is predominantly silt and clay with an average organic content of around 5 to 7 percent.

Overall the field data study produced solid results that were useful as input to further studies. There were some data gaps and noise within the data, but there were logical explanations and enough data collected to conclude that the field data study had been successful.

2.3 HYDRODYNAMIC STUDY

The primary objective of this 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 study developed a numerical hydrodynamic model using RMA-2, the TABS-MD modeling system with the Surface-water Modeling System as the graphical user interface. RMA-2 computes water surface elevations and horizontal velocity components. The computational mesh was designed to capture all of the major details of the existing and two proposed design alternatives. The design alternatives were both a 60-x-600-foot-deep channel. Plan 4 has a 1,350-foot diameter for the Brazosport Turning Basin while Plan 5 has a 1,100-foot diameter. This study takes into account the proposed LNG terminal. No hydrodynamic runs were made for the 1,200-foot-diameter turning basin, as the results from the 1,350-foot- and 1,100-foot diameter basins could be interpolated.

The numerical model was verified to the field data collection efforts. 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. 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. There is no discernible difference between the two plans for the tidal response. The deepening reduced the currents as much as 0.2 fps on the western side of the channel, with a small localized increase of 0.1 fps on the eastern flank of the channel. There is a greater reduction in ebb current magnitudes than in flood.

In conclusion, the plans had a slight effect on the phasing of the tides (approximately 30 minutes) and a minor increase in tide range. The current velocities were also slightly reduced. There is some minimal concern that the changes in tide and efficiency of the evacuating tidal prism can lead to changes in current velocities in the GIWW adjacent to the deepened channel, although these will likely be minimal.

2.4 NAVIGATION STUDY

Three alternative channel plans were simulated. All three plans assumed construction of the proposed LNG facility. The three ships modeled were the *Susan Maersk*, the 165k LNG Tanker, and the Very Large Crude Carrier (VLCC). The *Susan Maersk* measures 1,140 feet by 140 feet and drafts 47 feet, the 165k Tanker measures 990 feet by 156 feet and drafts 58 feet, and the VLCC measures 1,120 feet by 195 feet and drafts 58 feet.

Plan 1 is the 60-x-600-foot channel, a 1,350-foot-diameter turning basin at Brazosport, and deepening of a portion of the Channel to Stauffer to 50 feet and widening from 200 to 300 feet.

Plan 2 is the 60-x-500-foot channel, a 1,100-foot-diameter turning basin at Brazosport, and the 50-x-300-foot Stauffer Channel.

Plan 3 is the widening of the Entrance Channel to 600 feet.

Preliminary testing results abandoned plans 2 and 3, and plan 3 was modified into two alternate plans, plans 4 and 5.

Plan 4 will also have a 1,350-foot-diameter Brazosport Turning Basin, but the area northwest of the turning basin will be dredged to 60 feet in order to accommodate the additional turning radius needed.

Plan 5 varies only slightly from plan 4 in that the turning basin at Brazosport is reduced to 1,100 feet.

After several weeks of simulations, the study recommended the 60-x-600-foot channel, the 1,350-foot-diameter turning basin at Brazosport, some bend widening, and the Stauffer Channel improvements. The 1,350-foot-diameter basin was later changed to a 1,200-foot basin as described below.

Additional simulations were conducted in August 2007. The new simulations used a smaller containership for the Stauffer Channel and some tapering of the channel inside the jetty. The two plans simulated were the NED Plan of 60 x 540 feet and the LPP of 55 x 600 feet. The additional simulations indicated, based on pilot comments and test results, no real problems in this area for either the 60-x-540-foot or 55-x-600-foot plan. Navigation issues do not indicate either of these plans in preference to the other.

In 2010 additional ship simulations were done to include a Plan 6 and Plan 7 to reassess the need for the 1,350-foot-diameter turning basin. The design vessels included a VLCC with dimensions of 1,087 feet x 195 feet x 24 feet (which was always tested turning outbound and empty) and a Suezmax tanker with dimensions of 922 feet x 164 feet x 28 feet.

Plan 6 was a 1,200-foot-diameter turning basin, and plan 7 was a 1,350-foot diameter turning basin. The VLCC was minimally successful turning in the configuration in plan 7 and unable to turn in plan 6. The Suezmax was able to navigate the 1,200-foot-diameter turn, but pilots preferred a larger diameter basin if economically viable.

Based on the outcome of this final ship simulation study, the NED Plan and the LPP were adjusted to include a Brazosport turning basin diameter of 1,200 feet.

2.5 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 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 million cubic yards per year (cy/yr) to 2.92 cy/yr as a result of deepening and widening the channel to 60 x 600 feet.

Table 3
Dredging Requirements

Existing Configuration												
Reach #	Name	From	To	Length (feet)	Length (Miles)	Width (feet)	Area Factor	Depth (Feet)	Trap Factor	Combined Factor	Dredging (Cu Yd/Year)	Rate (CY/Year) Ft
Present												
1A	Entrance Bar Channel	-300 + 00	0 + 00	30,000	5.68	400	1	47	1	1	1,122,036	37.40
2	Jetty Channel	0 + 00	+71 + 52	7,152	1.35	400	1	47	1	1	189,491	26.49
3	Harbor Channel	+71+ 52	+184 + 20	11,268	2.13	400	1	47	1	1	280,000	24.85
	LTB Reach	+71 + 52	+78 + 52	700	0.13	400	1	47	1	1	17,394	24.85
	CH to Brzpt & Brzpt TB	+78 + 52	+115 + 52	3,700	0.70	1100	1	47	1	1	91,942	24.85
	CH to UP TB	+115 + 00	+132 + 66	1,766	0.33	400	1	47	1	1	43,884	24.85
	CH to UP TB and Upper TB	132 + 66	+184 + 20	5,154	0.98	400	1	47	1	1	128,072	24.85
4A	Lower Stauffer TB*	+184 + 20	+222 + 00	3,780	0.72	230	1	25	1	1	4,826	1.28
4B	Upper Stauffer TB*	+222 + 00	+260 + 00	3,800	0.72	200	1	25	1	1	5,000	1.32
			Total	56,000	11						1,601,353	91.34
LPP												
Reach #	Name	From	To	Length (feet)	Length (Miles)	Width (feet)	Area Factor	Depth (Feet)	Trap Factor	Combined Factor	Dredging (Cu Yd/Year)	Rate (CY/Year) Ft
1	LPP Extension	-433 + 00	-300 + 00	13,300	2.52	600	1.50	59	1.26	1.76	873,159	65.65
1A	Entrance Bar Channel	-300 + 00	0 + 00	30,000	5.68	600	1.50	59	1.26	1.76	1,969,531	65.65
2	Jetty Channel	0 + 00	+71 + 52	7,152	1.35	600	1.50	57	1.21	1.71	324,554	45.38
3	Harbor Channel	+71+ 52	+184 + 20	11,268	2.13						348,413	30.92
	LTB Reach	+71 + 52	+78 + 52	700	0.13	400	1.00	57	1.21	1.21	21,095	30.14
	CH to Brzpt & Brzpt TB	+78 + 52	+115 + 52	3,700	0.70	1350	1.23	57	1.21	1.44	132,400	35.78
	CH to UP TB	+115 + 00	+132 + 66	1,766	0.33	400	1.00	57	1.21	1.21	53,220	30.14
	CH to UP TB and Upper TB	132 + 66	+184 + 20	5,154	0.98	400	1.00	52	1.11	1.11	141,697	27.49
4A	Lower Stauffer TB*	+184 + 20	+222 + 00	3,780	0.72	300	1.30	52	2.08	2.38	11,507	3.04
4B	Upper Stauffer TB*	+222 + 00	+260 + 00	3,800	0.72	200	1.00	27	1.08	1.08	5,400	1.42
			Total	69,300	13						3,532,563	146.42
NED												
Reach #	Name	From	To	Length (feet)	Length (Miles)	Width (feet)	Area Factor	Depth (Feet)	Trap Factor	Combined Factor	Dredging (Cu Yd/Year)	Rate (CY/Year) Ft
1	NED Extension	-450 + 00	-300 + 00	15,000	2.84	600	1.50	64	1.36	1.86	1,044,448	69.63
1A	Entrance Bar Channel	-300 + 00	0 + 00	30,000	5.68	600	1.50	64	1.36	1.86	2,088,897	69.63
2	Jetty Channel	0 + 00	+71 + 52	7,152	1.35	540	1.35	62	1.32	1.67	316,289	44.22
3	Harbor Channel	+71+ 52	+184 + 20	11,268	2.13		0.00		0.00		364,713	32.37
	LTB Reach	+71 + 52	+78 + 52	700	0.13	400	1.00	62	1.32	1.32	22,946	32.78
	CH to Brzpt & Brzpt TB	+78 + 52	+115 + 52	3,700	0.70	1350	1.23	62	1.32	1.55	142,181	38.43
	CH to UP TB	+115 + 00	+132 + 66	1,766	0.33	400	1.00	62	1.32	1.32	57,889	32.78
	CH to UP TB and Upper TB	132 + 66	+184 + 20	5,154	0.98	400	1.00	52	1.11	1.11	141,697	27.49
4A	Lower Stauffer TB*	+184 + 20	+222 + 00	3,780	0.72	300	1.30	47	1.88	2.18	4,826	1.28
4B	Upper Stauffer TB*	+222 + 00	+260 + 00	3,800	0.72	200	1.00	27	1.08	1.08	5,000	1.32
			Total	71,000	13						3,824,173	218.44

* Estimated Dredging is calculated using difference between assumed channel depth at deauthorization (approx. 1950) and current depth (2009).

Dredging requirements for the LPP/NED Plan 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. Table 3 indicates dredging maintenance requirements for the Existing Configuration, the LPP, and the NED plans. Estimated dredging in the Stauffer Turning Basin is calculated using assumed channel depth at deauthorization (approximately 1950) and at current depth (2009). Existing configuration assumes keeping nondredged depths and widths.

2.6 HURRICANE-INDUCED STORM SURGE CONDITIONS

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 were the 60-x-600-foot channel with the 1,200-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 (Advanced Circulation) model that was developed for a coastal erosion study was adapted to depict the planned harbor configuration. Hurricanes selected for simulating were based on the September 1941 hurricane and Hurricane Fern, which impacted the Texas coast in September 1971. These hurricanes were selected for simulation because both came within close proximity of the study area and produced relatively high surges. (Stronger hurricanes, such as the 1900 Hurricane, were omitted from this analysis because they would have generated significantly greater overland flooding; this, in turn, hampers determining whether the planned improvements make the harbor more susceptible to storm surge.) Furthermore, the two hurricanes provided two angles-of-approach; the 1941 hurricane approached the coast from the southwest, whereas Hurricane Fern skirted the coast while moving from the northeast to the southwest. The data came from NOAA’s HURicane DATabase (HURDAT), which contains the latitude and longitude locations of the eye of the hurricane with corresponding central pressure and maximum wind speeds at 6-hour intervals.

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.

2.7 SHORELINE IMPACT STUDY

The purpose of the study is 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.

The four proposed plans were the 50-x-600-foot, 55-x-600-foot, 58-x-540-foot, and 60-x-540-foot channels.

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 five different bathymetry grids corresponding to the existing and proposed channels.

Average wave heights were a meter, periods were a little over 5 seconds, and there was a broad spread in wave direction with a small majority from the south. Bathymetry data came from NOS hydrographic surveys from GEODAS vs 4.0 developed by the National Geophysical Data Center.

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 feet per year. Five to 6 miles northeast of Freeport Harbor, the shoreline is shown to be stable, and farther northeast, it again becomes erodible. Between the Brazos and the San Bernard River mouths, the shoreline is very dynamic, with strong erodible and accretion regions.

The conclusion from this analysis is that if any of the proposed deepening alternatives for the Freeport Entrance 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. Net transport is primarily to the southwest. Breaker heights do not exceed 10 percent change anywhere and become negligible within 4 miles of the harbor entrance. For the most common occurring wave dataset, maximum wave heights increase by only 3 percent mainly within the left portion of the channel and maximum decrease is 9 percent in the right of the channel with along-shoreline changes of less than 2 percent extending less than 3 miles from the jetties.

The model predicts that the greater the proposed depth alternative, the greater the shoreline change, but for any alternative, these impacts will be minor and will not extend farther than 3 to 4 miles on either side of the Freeport jetties.

3.0 STRUCTURAL ENGINEERING

3.1 INTRODUCTION

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

This structural engineering portion of the Engineering Appendix to the Feasibility Report 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.

LPP and NED Plans. The LPP was identified in October 2006, and the NED Plan, which differs from the LPP, was outlined in July 2006 (Table 4):

Table 4
Comparison of NED Plan and LPP

Channel Reach	NED Plan	LPP
Proposed Extension	64 x 600 feet	59 x 600 feet
Outer Bar	64 x 600 feet	59 x 600 feet
Jetty Channel	62 x 540 feet	57 x 600 feet
Lower Turning Basin (LTB)	62 feet x Existing	57 feet x Existing
Channel to Brazosport & New 1,200-foot Turning Basin	62 x 1,200 feet TB	57x1,200 feet TB
Channel from Brazosport Turning Basin	62 feet x Existing	57 feet x Existing
Channel to Upper Turning Basin & Upper Turning Basin	52 feet x Existing	52 feet x Existing
Stauffer Channel Lower Reach	52 x 300 feet	52x300 feet
Stauffer Channel Upper Reach	27 feet x Existing	27 feet x Existing

3.2 FUNCTIONAL DESIGN REQUIREMENTS

The Project Management Plan (PMP) for feasibility studies on Freeport Harbor Dredging was prepared by the PDT in cooperation with the non-Federal sponsor in March 2003. The PMP is a document that presents the activities required to accomplish the feasibility study and submit a feasibility report to Congress for authorization. Freeport Harbor is a deep-draft navigation project that connects harbor facilities in the Freeport area with the Gulf of Mexico as follows:

Outer Bar Channel	400 feet wide x 47 feet deep
Main Channel	400 feet wide x 45 feet deep
Turning Basin(s)	750–1,200 feet diameter x 45 feet deep
Brazos Harbor Channel	200 feet wide x 36 feet deep
Brazos Harbor Turning Basin	750 feet wide x 36 feet deep

Alternatives for deepening and widening of Freeport Harbor were screened for structures in the following increments:

Outer Bar Channel and Jetty Channel
Lower Turning Basin
Lower Turning Basin to Upper Turning Basin
Upper Turning Basin
Brazos Harbor Channel (no change)
Brazos Harbor Turning Basin (no change)
Stauffer Channel
Stauffer Channel Turning Basin

Docks and wharfs were not analyzed by structures (EC-ES), and several were identified as requiring modifications due to the proposed incremental increases or channel improvement (tables 5 and 6). These docks and berthing areas that would utilize the new project depth are identified below and had dredging volumes estimated. The volumes were computed by taking the area of the berth multiplied by assumed depth of cut. All berthing areas were assumed to be at the existing depth of the waterway. Associated costs relating to the facility’s ability to utilize the new deep draft were identified by others.

Table 5
Freeport Dock Berths Current Depth

Berth	Owner	Location	Contract No.	Water Depth, feet		Berthing Area, SF	Upgrade Cost, ($1,000)[2]	Remarks
				Current	Design			
2	ConocoPhillips	166+00	6	45	50	152,000	7,500	820 feet LOA Design Vessel
3	ConocoPhillips	173+00	6	45	50	152,000	7,500	820 feet LOA Design Vessel
4	ConocoPhillips	B.H. 22+00	2	14	20	N/A	N/A	Barges Only
1	Seaway/TEPPCO	133+00	6	20	20	N/A	N/A	Barges Only
2	Seaway/TEPPCO	124+00	6	45	60	270,000	0	Outside Berth
3	Seaway/TEPPCO	124+00	6	45	60	[1]	[1]	Inside Berth
1	Dow	Stauffer Channel	7	15	25	N/A	N/A	Barges Only
3A	Dow	119+00	6	16	20	N/A	N/A	Barges Only
8	Dow	82+00	5	44	45	130,000	7,500	
13	Dow	77+00	5	< 20		N/A	N/A	Barges Only
14	Dow	75+00	3	45	47	180,000	7,500	
22	Dow	107+00	5	45	47	130,000	7,500	

[1]Included in upgrade cost of Berth 2
[2] Cost to upgrade to NED Plan depths
[3] LOA means length overall

Table 6
Freeport Dock Description

Facility User/Owner	Description
N/A	Wave Barrier
Phillips 66 Co.	Freeport Terminal No. 1, Ship Dock No. 3
Phillips 66 Co.	Freeport Terminal No. 1, Ship Dock No. 2
N/A	SPL PIT /Barrier
Phillips 66 Co.	Freeport Terminal No. 2, Berth No. 1
Dow Chemical	Texas Operations, A-2 Dock
Phillips 66	Dock
Dow Chemical	Texas Operations, A-3 Dock
Dow Chemical	N/A
Dow Chemical	Texas Operations, A-6 Dock
Monsanto Co.	Quintana Barge
Quintana Marine	Boat Basin & Marine Railway Slip
U.S. Coast Guard Station	Freeport Mooring basin

Design Quality Control Plan Assumptions:

1. Existing jetties not to be destabilized, as deepening and widening of the channel will be modified as necessary.
2. Extensive saltwater barriers will not be required for any increased salinity due to proposed channel dredging.
3. Sufficient structural design is performed for placement area spill boxes and bridges, bulkhead and dock analyses to allow for Plans and Specifications (P&S) preparation.
4. Existing state highway bridges and utility towers will not be impacted by the proposed dredging.

Concept Design for Modifications. No modification to any shoreline facilities is expected.

Quantity Estimates. Estimated quantities for each of the facilities were given to cost estimating based on Table 5 provided by the non-Federal sponsor.

Refine New Work PAs. Structural considerations necessary during PED.

PA Outlet Structure Design. Standard drawings for drop-outlet structures.

3.3 TECHNICAL DESIGN CRITERIA

3.3.1 Corrosion Mitigation

Structural steel used on this project for drop-outlet structures and steel sheet-piling will be protected against corrosion by the use of protective coatings (paint). The steel will be cleaned to bare metal by sandblasting and then coated with a suitable material to resist corrosion. Cathodic protection will not be used.

3.3.2 Security

Security measures for protecting the project against attacks, such as terrorism attacks, are not considered necessary because of the nature of the project. The only likely attack would be attempts to sink a vessel in order to block navigation. The sunken vessel can usually be removed within a few days to allow navigation to resume. The only vertical structures in this project are drop-outlet structures in the placement areas, but they are not considered likely attack targets because of the unimportant consequences of failure and because they can be repaired fairly quickly to restore their function.

3.3.3 Environmental Operating Principles

The purpose of this section is to provide examples of how the Engineering Appendix integrates Environmental Operating Principles as applicable to engineering and design as required for sustainability, preservation, stewardship, and restoration of the project area's natural resources. Also, this section provides additional detail as applicable for addressing USACE policy concerning risk and uncertainty.

As part of incorporating USACE "Environmental Operating Principles," including maintaining "accountability under the law for activities and decisions under our control that impact human health and welfare," the PDT identified no potential for Hazardous, Toxic, and Radioactive Waste.

3.3.4 Risk and Uncertainty

No potential for contaminated materials was identified or included in the DMMP for the placement of maintenance material from the 50-year life of the proposed project.

Additional risk and uncertainty with regards to other areas in the project are:

Dredging: In order to minimize water quality degradation, the most efficient dredging techniques and equipment will be utilized for new work and maintenance dredging. Also, any contaminants in the dredged material would be properly addressed. Further, all necessary efforts would be undertaken to reduce any adverse impacts.

Dredge Material Disposal: Selection of PA sites and placement of dredged material were optimized for existing and new PAs so that the sizing of upland disposal sites was reduced to the best-fit extent possible.

Contingencies for all contracts were developed using the Cost and Schedule Risk Analysis (CSRA) process and the Crystal Ball software as referenced in Section 5.0, Cost Engineering.

4.0 GEOTECHNICAL

4.1 PURPOSE

This section has been prepared to provide supporting technical information pertaining to the geotechnical aspects of the Freeport Harbor Deepening and Widening Project, including the disposal site development plan, proposed dredge material distribution to the disposal sites, available project soils information, and preliminary design parameters used. Use of available geotechnical investigations information, establishment of suitable design parameters and geotechnical assumptions, and production of quantities for a 50-year dredge disposal plan have been performed with the purpose of providing sufficient detail to substantiate the recommended plan and the baseline cost estimate.

4.2 PROJECT CONDITIONS

4.2.1 General Geology

The Freeport Harbor project area is situated in the eastern portion of the Colorado-Brazos deltaic plain. Formations across the plain become progressively younger in the seaward direction. These formations consist of sediments deposited during the Cenozoic era. Beach areas in the vicinity are composed primarily of littoral sands and shell of recent age. Heavy calcareous clays with interbedded silt and sand strata, Pleistocene in age, underlie the recent sediments. The natural land surface slopes gradually upward from elevations of about 3 to 4 feet above mean sea level behind the beaches to an elevation of 15 feet above mean sea level about 15 miles inland.

4.2.2 Soils Investigation

Subsurface soil investigation samples taken at locations in the project area are shown on Engineering Plates F1 and F2, with accompanying boring log profiles on plates F3 through F13. Freeport Harbor Channel borings, shown on plates F3 through F5, were obtained during the period from November 1962 to September 1978 and generally have been drilled down to elevations ranging from 40 to 90 feet below MLT. Additional borings in the vicinity of the channel were obtained by Fugro Consultants LP in January and February of 2005 under the direction of the Port of Freeport for a separate Widening project. Subsurface soil information is contained in a report (dated February 2006) entitled "Geotechnical Study - Jetty Stability and Channel Widening Project - Freeport Ship Channel - Port of Freeport - Freeport, Texas," by Fugro Consultants LP. Subsurface soil profiles for PAs 8 and 9, located on plates F6 and F7, were obtained in November 2005 and the investigation depth ranges from natural ground to 40 feet below. Additional subsurface soil samples were taken at PAs 8 and 9 in 2008 to verify the previous soil investigation conducted in November 2005. Boring logs for existing PA 1, located on plates F8 through F13, are from boring log data in a report by 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 and range from 20 to 60 feet deep.

4.2.3 Sampling and Testing

Cohesive subsurface soil samples were taken according to ASTM D 1587 "Standard Practice for Thin-Wall Tube Geotechnical Sampling of Soil." Undisturbed cohesive samples were taken at every 2-foot interval, and undrained shear strength was measured for each cohesive sample with a hand penetrometer. Field visual classification was performed, and information was recorded for each sample when the sample was taken at the site.

Cohesionless soil samples were taken according to ASTM D 1586 “Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils.” Spilt-spoon sampling was primarily employed on cohesionless to semicohesionless soil layers, whereby disturbed samples were taken in a glass jar at ever 5-foot interval if the cohesionless strata is greater than 5 feet. Field visual classification was conducted and recorded for each cohesionless sample.

Initial ground water depth was measured and recorded, and a free water depth was also measured and recorded at 24-hour time frames.

Selected samples were tested in accordance with a respective ASTM Standard such as ASTM D 2216 “Moisture Content,” ASTM D 4318 “Liquid and Plastic Limit,” ASTM D 1140 “Abbreviated Mechanical Analysis,” ASTM D 2166 “Unconfined Compression Test,” ASTM D 2487 “Engineering Classification of Soil,” ASTM D 4767 “Consolidated Undrained Triaxial Test,” and ASTM D 698 “Standard Compaction Test.” Selected sample test summary and undrained triaxial shear strength test results from Contract No. DACW64-03-D-0008 (FY 06) Delivery Order No. 0044 is attached. The results of these tests along with field boring log data were used to obtain engineering properties for the Jetty, Pas 8 and 9 containment dike, and foundation design. Through various testing programs associated with borings discussed herein, Unconfined Compression Tests (UC) and Consolidated Undrained Triaxial Compression Tests (CU) on representative samples have been utilized for estimates of undrained shear strengths for “end of construction.” For undrained shear strength estimates, in some cases the UC laboratory results have been used in conjunction with field hand penetrometer testing data that was recorded on the field boring logs. A correlation from standard penetration testing was 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 sands and silts layers).

Subsurface soil investigation lab test results and soil strata profiles are attached to this appendix.

4.3 UPLAND PLACEMENT AREAS

4.3.1 Existing Placement Area 1

Existing PA 1 is located in Freeport, about ½ mile south of Highway 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 containment dike, an assumed average interior elevation of 26 feet MLT, and assumed average containment dike elevation of 29 feet MLT. Assumed average elevations are based on anticipated elevations following the completion of O&M contract awarded in 2009.

4.3.2 New Placement Area 8

New PA 8 is located in Freeport, just north of Highway 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.

4.3.3 New Placement Area 9

New PA 9 is located in Freeport, just north of Old Highway 36, and approximately 300 feet west of the Brazos River Diversion Channel. PA 9 is about 254 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.

4.3.4 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.

4.4 OCEAN DREDGED MATERIAL DISPOSAL SITES - ODMDS

There are two ODMDSs for the maintenance and new work material. One is about 1,291 acres and the other is 2,236 acres, respectively. Below is the horizontal coordinates for the ODMDSs:

1. Maintenance Material ODMDS Coordinates (NAD 83) are as follows:

   X = 3,163,694 Y = 13,530,298

   X = 3,166,836 Y = 13,527,077

   X = 3,157,888 Y = 13,518,349

   X = 3,154,745 Y = 13,521,570

2. New Work Material ODMDS Coordinates (NAD 83) are as follows:

   X = 3,169,494 Y = 13,516,802

   X = 3,174,571 Y = 13,511,584

   X = 3,164,981 Y = 13,502,254

   X = 3,159,904 Y = 13,507,472

Additional discussions about these sites can be found in the Environmental Impact Statement document for this project.

4.5 DREDGED MATERIAL FACTORS

4.5.1 Bulking Factor

The bulking factor is a design parameter primarily used to develop containment dike height requirements for each dredge event. The bulking process is a result of the structural disruption of the dredged sediments and the entrainment of water into the sediments during dredging. This factor is traditionally defined as the ratio of the volume occupied by the dredged material in the placement area immediately after completion of dredging to the volume occupied by the same material in the channel before dredging.

$$\textit{Bulking Factor} = \frac{\textit{(Volume of Dredged Material in Placement Area)}}{\textit{(Volume in Channel Prior to Dredging)}}$$

The amount of bulking varies with the type of sediments and the method of dredging (mechanical or hydraulic). Other factors that affect bulking include size of dredge, horsepower, and residence time in the pipeline. For this project, dredging will primarily be conducted hydraulically. The new work dredging for this project will consist of 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 available boring data from the Upper Turning Basin on out to sea.

Development of containment dike height requirements on this project was based on a bulking factor of about 1.3 for maintenance material and about 2 for the portion of new work material anticipated to go into a slurry state before final discharge at the disposal sites. The remaining portion of new work material that will come out of the dredge pipe in the form of solid clay fragments (informally referred to as “clay balls”) or segregate from the dredge mixture soon after discharge (such as sands) is anticipated to remain fairly close to the original density from the channel.

4.5.2 Retention Factor

For calculations and quantities produced on this project, the definition adopted for the term “retention factor” is the fraction of new work material from the channel that, when dredged to the site, retains a degree of consistency from the original in situ state necessary for use as fill materials for hydraulic containment dike and containment dike foundation construction or future borrow for future mechanical containment dike construction; and that, when pumped to the site, tends to accumulate or stack within the general vicinity of the end of the dredge pipe.

Retention Factor = $\frac{\textit{(Volume of Dredged Material Suitable for Containment Dike Fill Material)}}{\textit{(Actual Dredging Quantity)}}$

Variables that can influence this factor include original in situ material properties and consistencies, size of dredge, type and control of cutter head, horsepower, and pump distance. For feasibility level, a retention factor of about 0.5 was assumed for this project.

4.5.3 Shrinkage Factor

The shrinkage factor is a design parameter used to evaluate the long-term storage capacity of a PA for use in developing the DMMP. It is defined as the ratio of the long-term volume occupied by a certain quantity of dredged material in a PA, to the volume it occupied in the channel prior to dredging. Generally, this parameter is associated with maintenance material, but may also be associated with new work material.

Shrinkage Factor = $\frac{\textit{(Long-term Volume in Disposal Area)}}{\textit{(Volume in Channel Prior to Dredging)}}$

Items that affect the shrinkage include the soil composition, pan of evaporation rate, consolidation, desiccation, climatological conditions, drainage efficiency or dewatering measures implemented, and dredging schedule of maintenance material placed at the sites. Determination of a precise shrinkage factor for a placement area can be a complex task and include modeling the consolidation and desiccation shrinkage based on laboratory test data, climatological data, drainage characteristics, and operational characteristics. For feasibility level, the development of the long-term storage capacity and containment dike height requirements on this project was based on a shrinkage factor of about 0.65 for maintenance material.

4.6 MECHANICAL CONTAINMENT DIKE CONSTRUCTION AND NEW WORK PLACEMENT PLAN

At PAs 8 and 9, during initial construction, the proposed plan involves using borrow material from the interior of the sites to mechanically raise the perimeter containment dikes to an estimated height to contain the new work materials, which are slurry materials generated from degraded new work. During new work dredging, the hydraulic new work materials will be placed along the perimeter containment dikes at PAs 8 and 9, to the inside of the placement areas to serve as a foundation for future containment dike raising and strategically placed stockpile to be reshaped to desired containment dike heights during subsequent O&M cycles. At PA 1, it is anticipated that borrow materials for O&M containment dike construction will generally be obtained through conventional side-cast methods. The initial containment dike elevations and projected future containment dike elevations at the placement areas, to accommodate project capacity needs, are shown in Table 7.

4.7 50-YEAR DREDGED MATERIAL MANAGEMENT PLAN

4.7.1 Environmental Restrictions Pertaining to Upland and Offshore Dredged Material Placement

4.7.1.1 Upland Placement Area Water Quality

The upland PA containment dike 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 containment dike 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.

4.7.1.2 Offshore Placement Areas

Offshore placement areas have been modeled by PBS&J under direction of and coordination with the Galveston District Environmental Section. A computer model referred to as MDFATE (Multiple Disposal Fate) was utilized by PBS&J to analyze the effects of offshore placement to ensure conformance with fill height restrictions on the bottom of the seafloor and other restrictions as worked out between the Environmental Protection Agency and USACE for a 50-year placement plan. Further details of the restrictions and agreements can be found in the accompanying Environmental Impact Statement. The estimated offshore dredge quantities for the new project are shown in Table 6.

4.7.2 Dredged Materials and Potential for Beneficial Use

Results from bed sediment studies (from the *Desktop Sediment Study for Freeport Project* generated by ERDC and H&H), for bed sediment data collected between September of 1987 through May of 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.

On a separate widening project currently pursued by the Port of Freeport, potential beneficial uses of dredge materials were considered, including marsh restoration, beach nourishment, an energy-dissipating berm, habitat berm, and feeder berm. These features are described in further detail in the Environmental Impact Statement document dated February 2007, that accompanies the Feasibility Report for the “Freeport Entrance and Jetty Channel Widening Project.”

Based on groundwork done in the Widening Project study by 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 PDT on the USACE’s deepening and widening project to forgo pursuit of beneficial use features in the final selected dredged material management plan.

4.7.3 Fifty-Year Capacity and Dredged Material Placement Designation

Table 7 contains the 50-year containment dike elevations required for capacity and the anticipated cyclical maintenance dredging. Table 8 contains the breakout of new work from the channel and anticipated distribution to the placement area sites.

4.8 JETTY STABILITY ANALYSIS

4.8.1 Scope

The scope of this study was identified at a PDT meeting in January 2006. The scope was as follows: given possible restrictions to channel depth and width due to jetty stability issues, determine:

a. the maximum channel width at a project channel depth of 60 feet
b. the maximum channel depth at a channel width of 600 feet

   (Note: for an authorized depth of 60 feet, it was anticipated that the required depth in the Jetty Channel would be 62 feet 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 time of analysis were reviewed including postdredging channel cross sections dated January 2006 and jetty/channel cross sections dated December 2005. In addition, the history and performance of the jetties was discussed with the USACE Operations Division. Two project constraints were established regarding the configuration of the jetty slopes:

Table 7
Freeport Harbor Deepening and Widening – Summary of Maintenance Dredging and Placement Area Parameters

Freeport Harbor Deepening & Widening - Summary of Maintenance Dredging & Placement Area Parameters																	
Alternative	Channel Reaches	Channel Reach Stationing		Annual Shoaling Rate From Channel Reaches (CY)	Dredging Stationing & Placement Site Designation			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)
		To	From		To	From	Site										
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.

Table 8
Freeport Harbor Deepening and Widening – 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)**
		From	**To**				**From**	**To**	**Site**	
NED	Future Channel Extension	–300+00	–470+00	2,000,000	670,000	2,670,000	-300+00	-470+00	ODMDS 1	14,957,000
	Outer Bar Channel	0+00	300+00	7,800,000	1,300,000	11,100,000	0+00	-300+00		
	Jetty Channel	71+52	0+00	2,900,000	287,000	1,187,000	71+52	0+00		
	Lower Turn Basin	78+52	71+52	280,000	38,000	318,000	78+52	71+52	PA 8	2,087,559
	Ch to Brazosport & New 1,200-foot Brazosport TB	115+00	78+52	2,200,000	116,000	2,316,000	702+00	78+52		
							115+00	102+00	PA 9	3,397,441
	Ch from Brazosport TB	132+66	115+00	513,000	34,000	547,000	132+66	115+00		
	Ch to Upper TB & Upper TB	184+20	132+66	380,000	110,000	490,000	184+20	132+66		
	Stauffer Channel, Lower Stauffer TB	222+00	184+20	1,340,000	47,000	1,387,000	220+00	184+00		
	Stauffer Channel, Upper Staffer & TB	260+00	222+00	390,000	37,000	427,000	260+00	220+00		
	Total			**20,803,000**	**2,639,000**	**20,442,000**				**20,442,000**
LPP	Future Channel Extension	–300+00	–370+00	500,000	295,000	795,000	–470+00	–300+00	ODMDS 1	9,733,297
	Outer Bar Channel	0+00	-300+00	4,990,000	1,300,000	8,290,000	–300+00	00+00		
	Jetty Channel	71+52	0+00	2,345,000	303,000	648,000	00+00	71+52		
	Lower Turn Basin	78+52	71+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	115+00	78+52	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	132+66	115+00	357,000	34,000	391,000	115+00	132+66		
	Ch to Upper TB & Upper TB	184+20	132+66	380,000	110,000	490,000	132+66	184+20		
	Stauffer Channel, Lower Stauffer TB	222+00	184+20	1,340,000	47,000	1,387,000	184+20	222+00		
	Stauffer Channel, Upper Staffer & TB	260+00	222+00	390,000	37,000	427,000	222+00	260+00		
	Total			**15,072,000**	**2,280,000**	**14,352,000**				**14,352,000**

a. do not undercut the toe of the South Jetty

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

4.8.2 Critical Locations and Findings

4.8.2.1 End of Construction Stability

In reviewing of prior stability analysis conducted by Fugro Engineering on the prior Deepening and Widening project, these results have indicated the “long-term” factors of safety for widening scenarios to be notably lower than the “end of construction” factors of safety. Additionally, after a number of long-term stability analysis trials were run on the new Deepening Project, an “end of construction” stability analysis was conducted at a conservative location (South Jetty Station 10+00) based on the long-term results, and an “end of construction” factor of safety above 3 was realized for a 57-foot-deep channel configuration. Based on study of prior stability analyses done, the high factor of safety for follow-up “end of construction” analysis at conservative location, and engineering judgment, the decision was made to focus primarily on the long-term stability conditions for the new deepening project.

4.8.2.2 Long-Term Stability

Slope stability analyses for long-term conditions 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 for long-term conditions 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 long-term 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, 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 62/540 in Table 7. A second configuration (54/600) was determined by raising the elevation of the channel until a width of 600 feet was achieved. This channel depth was determined to be 54 feet. 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 62/540 channel and 120 feet to the north for the 54/600 channel). A summary of the calculated minimum factors of safety, resulting from stability analysis for long-term conditions, is provided in Table 9. For the long-term stability analyses, a minimum factor of safety criteria of 1.3 was adopted for the jetty, based on consideration of the consequences of failure and likelihood that a slide along the jetty would not be an immediate danger to human health or loss of life. The primary consequences of failure would be economic, and a factor of safety of 1.3 was considered to be reasonable.

Table 9
Jetty Stability Analysis - Summary of Calculated Minimum Factors of Safety

	Associated Soil Borings	Existing Conditions	62/540 Channel	54/600 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 Fugro Consultants, January 2005. Boring 74-23 taken by USACE, August 1974; and Boring 75-92 by USACE, October 1976.

4.9 CONTAINMENT DIKE'S SLOPE STABILITY ANALYSIS AT PA 8 AND PA 9

Slope stability analysis was performed with a computerized program "Slope W" for proposed new PAs 8 and 9 using the limited equilibrium procedures Morgenstern and Price analysis method.

The slope stability is determined by the factor of safety which is defined by:

Factor of Safety = <u>Total available shear (or moment) strength</u> / <u>shear stress (or moment) needed for static equilibrium</u>

Or $F = S / \tau$ C-1, EM 1110-2-1902

$F = (C' + (\sigma - u)\tan(\phi')))/ \tau$ C-2, EM 1110-2-1902

$F = (C + \sigma * \tan(\phi)) / \tau$ C-4, EM 1110-2-1902

Drained shear strength is determined in a soil laboratory through CU testing; undrained strength or total stress is related to total stress failure plane in CU plots. In addition to CU tests, a pen penetrometer reading can be used to estimate undrained shear strength during soil sampling; unconfined compression (UU) tests were also used to determine the undrained shear strength of a sample in soil laboratories. Due to economical constraints, only a few samples was selected for triaxial shear strength test. The test results of the samples are presented with the Mohr-Coulumb failure criterion plots in an attachment to this appendix; summaries of the rest of the test results and UU test information are also attached.

Total shear strength: $S = C + \sigma \text{ Tan}(\phi)$ 2-1, EM 1110-2-1902

Effective shear strength: $S = C' + \sigma' \text{ Tan}(\phi')$ 2-2, EM1110-2-1902

S = maximum possible value of shear strength

C = cohesion intercept

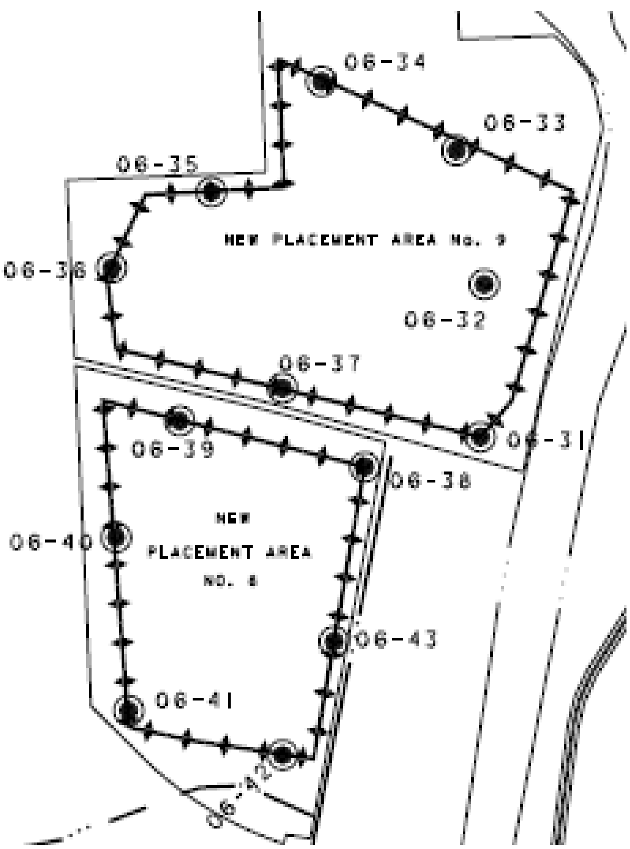
σ = normal stress on the failure plane

u = pore water pressure; ((σ-u) is the effective normal stress on the failure plane

ϕ = total stress friction angle

A precise analysis is unreasonable for engineering practice because of the variable natures of soil particles in the foundation and mathematical formulae. Since it is not economically feasible to obtained engineering properties of each sample, a geotechnical engineer's judgments are applied to select shear strength for slope stability analyses. After reviewing Delivery Order – (DO) #43 field boring logs, borings 06-31 and 06-43 soil strata information and the lab test results of each were utilized for an initial preliminary slope stability analyses for Pas 8 and 9 (Figure 1). Due to uncertain nature and individualistic of soil particles, slope stability analyses obtained from one or two boring locations with above minimum required factor of safety will not have guarantee of a foundation satisfactory for the rest of containment PAs. Additional slope stability analyses should be conducted during preconstruction design phase to investigate the stability factor of safety with the rest of the soil testing results.

Figure 1



Boring Locations for Containment Dike Stability Analyses at PAs 8 and 9

A two-phase construction was considered for the slope stability analysis for the new proposed PAs. “Phase I” consisted of constructing the dike to elevation of 23.0 feet MLT, about 18 feet lift from the assumed 5-foot natural ground elevation. “Phase II” containment dike construction was to raise from elevation 23 MLT to the final of dike elevation at elevation 34.0 feet. From the preliminary foundation analyses, the dike foundation is able to sustain a dike height greater than 34 feet MLT to provide an additional capacity for future dredge containment; however, a further foundation investigation is encouraged if such situations occur in the future.

The stability analysis results indicate that both Phase I and Phase II at the end of dike construction was above the required minimum factor of safety. However, in order to guarantee a longer service possibility and consolidate foundation material, an earthen berm at the outside toe of the dike was added to ensure the future containment dike raising probability. Minimum dimensions of the toe berm for Phase I and Phase II construction are 60 feet wide and 7 feet high, and 60 feet wide and 8 feet high, respectively. Table 10 summarizes the results.

Table 10
Results of Containment Dike Stability Analyses at PA 8 and PA 9

Proposed Dike Construction	Worst Soil Conditions at Boring Location	Required Minimum Factor of Safety	Toe Berm Dimensions	Computed Minimum Factor of Safety
Phase I	06-31	1.3	60’ (W) x 7’ (H)	2.92
	06-43	1.3	60’ (W) x 7’ (H)	2.86
Phase II	06-31	1.3	60’ (W) x 8’ (H)	2.53
	06-43	1.3	60’ (W) x 8’ (H)	2.22

4.10 CONTAINMENT DIKE AND CHANNEL TEMPLATES

A design slope of 3 to 1 (horizontal to vertical) for containment dike with 10-foot crown templates and channel cuts was selected for the feasibility level quantities computation. The design slope was analyzed and confirmed with preliminary stability analyses. Additional and more-detailed stability analyses are recommended and anticipated to be done during the PED phase. For the channel template, the 3:1 slope is consistent with the original plan presented in the General Design Memorandum No. 1 (dated April 1979).

4.11 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; thus, this would not be considered a new cost for the new channel deepening.

4.12 RECOMMENDED ADDITIONAL INVESTIGATIONS

4.12.1 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 the following: (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.

4.12.2 Upland Placement Areas

At existing PA 1, prior to the next O&M construction contract under the new 50-year project, it is recommended that additional borings be taken at locations that include but are not limited to (1) areas where containment dike alignment adjustments have taken place since prior drilling work done at the site, (2) locations where results from prior drilling/testing 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 dredged fill placement or other soil materials for use as borrow for the initial mechanical containment dike work.

4.12.3 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 containment dike height, recommend additional drilling be performed into containment dike foundations to verify extent of consolidation and foundation strength gain from surcharge of initial containment dike and new work stockpiles, and perform stability checks in critical foundation areas identified.

5.0 COST ENGINEERING

For this Feasibility Study of the deepening and selective widening of the Freeport Channel, two Mii estimates were developed: 1) National Economic Development (NED) Plan, and 2) Locally Preferred Plan (LPP). The current existing channel is 45 feet by 400 feet. See below for description of the NED Plan and the LPP.

The NED Alternative is referred to as the 60-foot by 540-foot project because the width of the Jetty Channel would be restricted to 540 feet. This alternative proposes to extend the Outer Bar Channel (Channel Extension) 3.2 miles farther into the Gulf of Mexico at a depth of 62 feet and a width of 600 feet, deepen the existing Outer Bar Channel to 62 feet and the Jetty Channel to 60 feet, deepen the main channel from the Lower Turning Basin through Station 132+66 (just above the Brazosport Turning Basin) to 60 feet and widen the Brazosport Turning Basin to 1,200 feet, deepen the main channel from Station 132+66 through the Upper Turning Basin to 50 feet, deepen and widen the Lower Stauffer Channel to 50 feet by 300 feet, and dredge the Upper Stauffer Channel to 25 feet deep by 200 feet wide in lieu of restoring its previous dimensions of 30 feet by 200 feet.

The LPP Alternative is referred to as the 55-foot by 600-foot project. This alternative proposes to extend the Outer Bar Channel (Channel Extension) 1.3 miles farther into the Gulf of Mexico at a depth of 57 feet and a width of 600 feet, deepen the existing Outer Bar Channel to 57 feet and the Jetty Channel to 55 feet, deepen the main channel from the Lower Turning Basin through Station 132+66 (just above the Brazosport Turning Basin) to 55 feet and widen the Brazosport Turning Basin to 1,200 feet, deepen the main channel from Station 132+66 through the Upper Turning Basin to 50 feet, deepen and widen the Lower Stauffer Channel to 50 feet by 300 feet wide, and dredge the Upper Stauffer Channel to 25 feet deep by 200 feet wide in lieu of restoring its previous dimensions of 30 feet by 200 feet.

Quantities and design features were developed by the Galveston District (SWG) Engineering Branch.

This estimate was prepared using the latest Unit Price Books and labor rates for fiscal year 2012 (October 2011). The estimate was divided into eight contracts, with each contract being organized in accordance with the work breakdown structure. The midpoint dates of the construction contracts were 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 15 September 2008. The costs were escalated in accordance with the above Engineering Regulation and EM 1110-2-1304, dated 31 March 2012. All this data was input into the Total Project Cost Summary Sheet (TPCS). The baseline estimate provides for all pertinent elements for a complete project ready for operations.

Since the project cost 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 estimates were prepared in April 2012.

ACCOUNT CODE 01 – LANDS AND DAMAGES: Cost for this Account Code was provided by SWG, Real Estate Division.

ACCOUNT CODE 06 – FISH AND WILDLIFE FACILITIES (MITIGATION): Quantities and design features were provided by SWG Planning, Environmental, & Regulatory Division. Costs were generated to develop prairie into coastal prairie. This involved removing existing tallow tress (classified as weeds) and creating an irregular-shaped pond with an average depth of 12 inches in the middle, using a dozer to clear and form the depression, and planting 400 clumps, 10 feet apart on center, with appropriate wetland plants.

ACCOUNT CODE 12 – NAVIGATION PORTS AND HARBORS: Dredge quantities were developed by the design engineer. Two large hopper dredges were assumed to be used simultaneously for each contract Nos. 1 and 2; and that they would be owned by the same contractor to allow for better coordination of maritime traffic to the open-water disposal site, where dredge material would be discharged. The remainder of the channel was assumed to be dredged using a 30-inch pipeline, with the material discharged into existing PA 1 or into two new PAs (8 and 9), located along the waterway. The dredging costs were developed using CEDEP. The dredge production rates were reduced to account for the stiffer “new work” material to be encountered. The costs for mobilization and demobilization were developed using CEDEP, assuming the dredges were based in New Orleans. The dredge estimates were based on standard operation practices for the Galveston District, which assumed conventional contractual practices of large business Invitations for Bid.

The cost for Sea Turtle Protection is associated with hopper dredging and includes (1) cost for two trawlers per hopper, (2) a sea turtle protection device fitted to the hopper, and (3) 24-hour monitoring survey.

The cost for creating a PA was included under this code of account. Part of the cost for creating a PA included clearing, grubbing, and stripping the area, as well as turfing the outside of the new levees. Labor rates and overhead costs were adjusted to reflect Region 6. The PA levees would be built using 2-cubic yard (cy) dragline buckets, with an optimal production rate of 150 cy/hour. A total of three draglines would be working at the same time. Material characteristics were provided by SWG, Engineering Division, Structural and Geotechnical, sections 3.0 and 4.0.

Also, included under this account code were navigation aids. The navigations aids included additional buoys and the relocation of four existing rang towers. All the quantities and cost data were provide by the Coast Guard in New Orleans.

ACCOUNT CODE 30 – ENGINEERING AND DESIGN: The cost for this account was developed using the guidelines provided in the TPCS, with the agreement of the cost engineer and the project manager.

ACCOUNT CODE 31 – CONSTRUCTION MANAGEMENT: The cost for this account was developed using the guidelines provided in the TPCS, with the agreement of the cost engineer and the project manager.

6.0 REFERENCES

Fugro Consultants LP. 2005. Fugro Consultants LP. Geotechnical Study - Jetty Stability and Channel Widening Project - Freeport Ship Channel - Port of Freeport - Freeport, Texas. February 2006.

PBS&J. 2007. PBS&J. November, 2007. Preliminary Draft Environmental Impact Statement, Freeport Harbor Deepening and Widening Channel Improvement Project, Brazoria County, Texas.

Professional Service Industries, Inc. 1996. Subsurface Exploration and Foundation Recommendations for the Proposed Confined Placement Site No. 1 – Port of Freeport – Freeport, Texas. June.

Shiner Moseley and Associates, Inc. 2007. Draft Feasibility Report – Freeport Entrance and Jetty Channel Widening Project, Freeport, Texas. June.

U.S. Army Corps of Engineers, Southwest Division (USACE SWG), Galveston District. 1979. General Design Memorandum No. 1 (Freeport Harbor, Texas, 45-foot Project, Phase II).

U.S. Army Corps of Engineers, SWG and ERDC. 2005. Desktop Sediment Study for Freeport Project. September.

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Attachment

Engineering Drawings and Soil Investigation Appendix

List of attachments:

Channel C-Drawings
C00 Cover Sheet
C01 General Notes & Index
C02 Project Location
C03 Existing Plan View
C04 Enlarged Plan View Stauffer
C05 Enlarged Plan View Jetty Reach
C06 General LPP Cross Sections

Geotechnical F-Drawings
F01 Chan Boring Plan
F02 PA#1, 8, & 9 Boring Plan
F03 Channel Boring Logs
F04 Channel Boring Logs
F05 Channel Boring Logs
F06 PA 8 & 9 Boring Logs
F07 PA 8 & 9 Boring Logs
F08 PA 1 Boring Logs
F09 PA 1 Boring Logs
F10 PA 1 Boring Logs
F11 PA 1 Boring Logs
F12 PA 1 Boring Logs
F13 PA 1 Boring Logs
F14 Typical Containment Dike Detail

Freeport Channel, Texas
Channel Improvement Feasibility Study

Pipeline/Hopper Dredging

Freeport Navigation Channel Improvement, Stauffer Channel Reauthorization & New Upland Confined PA's #8 and #9

APPROVAL COPY
SUBJECT TO REVISION

Coastal Navigation and Environmental Restoration

Office of the District Engineer
U. S. Army Engineer District, Galveston
Corps of Engineers
Galveston, Texas
March 2010

This project was designed by the Galveston District of the U.S. Army Corps of Engineers. The initials or signatures and registration designations of individuals appear on these project documents within the scope of their employment as required by ER 1110-1-8152.

CADD GALVESTON DISTRICT TOTAL ARMY QUALITY

PRINTED ON RECYCLED PAPER

GENERAL CONSTRUCTION AND DREDGING NOTE(S):

1. HORIZONTAL CONTROL BASED ON TEXAS STATE PLANE COORDINATE SYSTEM, SOUTH CENTRAL ZONE NAD83 IN FEET.
2. ALL ELEVATIONS SHOWN ON THESE PLANS ARE IN FEET REFERENCED TO NAVD88 OR MLT (MEAN LOW TIDE).
3. MLT DATUM IS 1.00' BELOW NAVD88 DATUM.

HORIZONTAL CONTROL MONUMENTS
N.A.D. - 83

DESCRIPTION	EASTING	NORTHING
CAPTAIN	3,151802.03	13,542,617.36
SMITH BURGER POINT	3,161,763.35	13,554,272.97
KBB-1	3,137,416.17	13,530,736.32
WEST JETTY POINT #1	3,151,984.37	13,543,015.85
WEST JETTY POINT #2	3,151,476.34	13,543,536.55
SOUTHEAST CORNER D.A. #2	3,146,325.36	13,539,894.98
E-6	3,156,924.73	13,548,966.59
F.H.-3	3,149,745.88	13,544,667.91
F.H.-6	3,144,294.50	13,541,164.37
F.H.-7	3,142,151.04	13,541,280.05
REDBUG	3,146,163.21	13,543,611.69
JM-2	3,140,824.37	13,544,303.41
JM-3A	3,142,439.40	13,542,550.49
BPTB #4	3,144,877.76	13,544,585.26

4. CONTRACTOR SHALL CONTACT PIPELINE OWNERS AND VERIFY THE POSITION OF PIPELINES PRIOR TO PERFORMING WORK IN THE DESIGNATED WORK AREA.
5. CONTRACTOR SHALL VERIFY ACCURACY OF CONTROL MONUMENTS PRIOR TO CONSTRUCTION.
6. CONTRACTOR SHALL VERIFY ALL EXISTING CONDITIONS PRIOR TO COMMENCING CONSTRUCTION ACTIVITIES. CONTRACTOR SHALL TAKE MEASURES TO PROTECT ALL EXISTING IMPROVEMENTS WITHIN AND ADJACENT TO THE WORK AREA.
7. PRIOR TO COMMENCING DREDGING, CONTRACTOR SHALL PERFORM A PRE-DREDGE HAZARD SURVEY OVER WORK AREA TO LOCATE ANY BURIED OBSTRUCTIONS OR UNCHARTED PIPELINES THAT MAY BE PRESENT.
8. MATERIAL SHALL BE DEPOSITED WITHIN THE LIMITING LINES OF THE DESIGNATED PLACEMENT AREAS, AS PRESCRIBED IN THE SPECIFICATIONS.

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-	COVER SHEET
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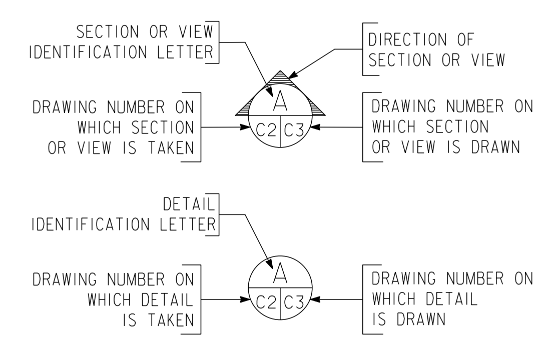
F-11	F11 PA 1 Boring Logs.dgn
F-12	F12 PA 1 Boring Logs.dgn
F-13	F13 PA 1 Boring Logs.dgn
F-14	F14 Typ Levee.dgn



SECTION AND DETAIL CROSS REFERENCE

US Army Corps of Engineers
Galveston District

Rev.	Description	Date	By

Drawn by: X
Designed by: X
Checked by: X
Date: X
Rev.
Scale: AS SHOWN
Submitted by: DAVID R. BROWN, P.E.
Chief, General Engineering Section
Approval Recommended: HARRISON T. SUTCLIFFE, P.E.
Chief, Engineering Branch
Approved by: PETE G. PEREZ, P.E.
Chief, Engineering and Construction Division

U.S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS

PREPARED UNDER THE DIRECTION OF
DAVID C. WESTON, Col., C.E.,
DISTRICT COMMANDER

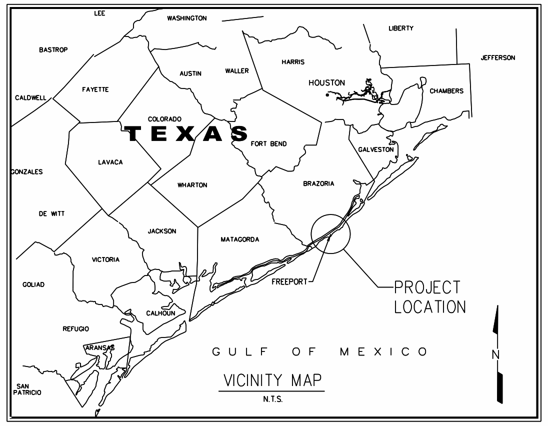
INDEX OF DRAWINGS
&
PROJECT
CONSTRUCTION INFORMATION

Drawing No.: C01

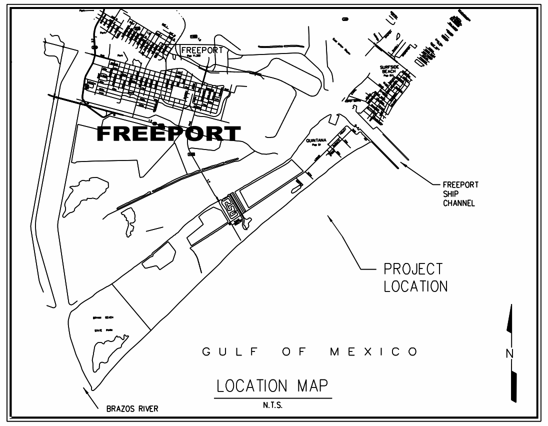
Sheet of X

File No.

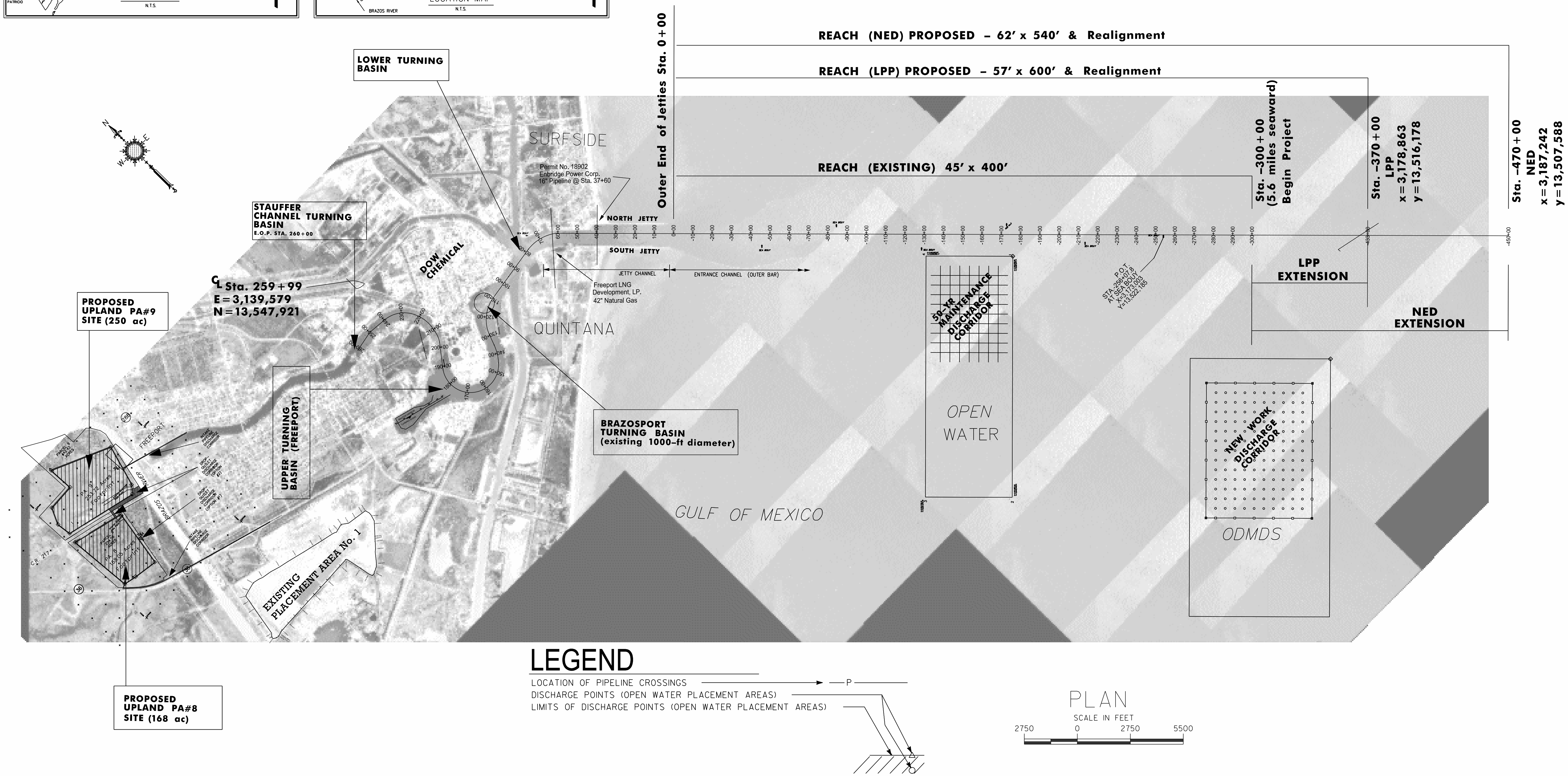
KEYMAP
(PROJECT LAYOUT)



VICINITY MAP
N.T.S.



LOCATION MAP
N.T.S.



LEGEND

LOCATION OF PIPELINE CROSSINGS — P —
DISCHARGE POINTS (OPEN WATER PLACEMENT AREAS)
LIMITS OF DISCHARGE POINTS (OPEN WATER PLACEMENT AREAS)

PLAN
SCALE IN FEET
2750 0 2750 5500

US Army Corps of Engineers
Galveston District

Rev.	Description	Date	By

Drawn by: X
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Checked by: X
Dates: X
Scales: AS SHOWN
Submitted by: DAVID B. BROWN, P.E., Chief, General Engineering Section
Approval/Recommended: HARRISON T. SUTCLIFFE, P.E., Chief, Engineering Branch
Approved by: PETE G. PEREZ, P.E., Chief, Engineering and Construction Division

U.S. ARMY ENGINEER DISTRICT, GALVESTON
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GALVESTON, TEXAS

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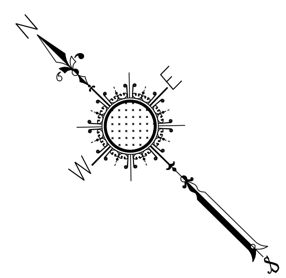
DISTRICT COMMANDER

PROJECT OVERALL FEATURES
(KEYMAP)

Drawing No.:
C02
Sheet of X
File No.

3/1/2



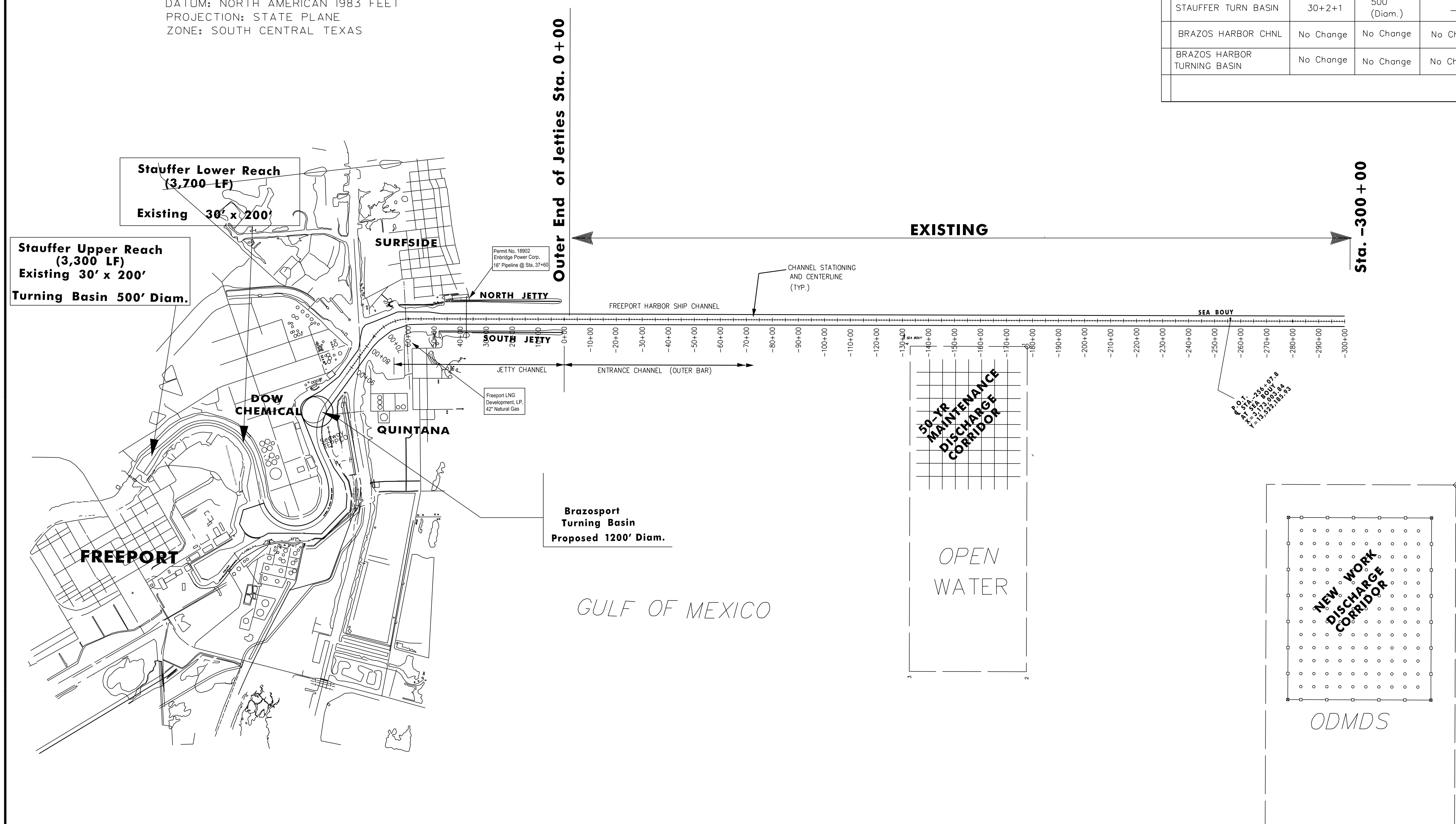
PLAN

SCALE IN FEET

2250 0 2250 4500

DATUM: NORTH AMERICAN 1983 FEET
PROJECTION: STATE PLANE
ZONE: SOUTH CENTRAL TEXAS

	SECTION OF WATERWAY	EXISTING PROJECT DIMENSIONS (IN FEET)		MODIFIED DIMENSIONS			
				PROPOSED LPP 57' X 600' (IN FEET)		PROPOSED NED 62' X 540' (IN FEET)	
		DEPTH (M.L.T.)	BOTTOM WIDTH	DEPTH (M.L.T.)	BOTTOM WIDTH	DEPTH (M.L.T.)	BOTTOM WIDTH
	PROPOSED EXTENSION	NONE	NONE	–	–	–	–
	OUTER BAR CHANNEL	45+4+2	400	–	–	–	–
	JETTY CHANNEL	45+2+2	Transition 400	–	–	–	–
	LOWER TURNING BASIN	45+4+2	750 (DIA.)	–	–	–	–
	CHNL TO BRAZOSPORT TURNING BASIN	45+4+1	Transition 1,000 (DIA.)	–	–	–	–
	CHNL TO FROM BRAZOSPORT	45+4+1	Transition	–	–	–	–
	UPPER TURNING BASIN	45+2+1	1,200'	–	–	–	–
	CHANNEL TO STAUFFER (LOWER REACH 3,700LF)	30+2+1	200'	–	–	–	–
	CHANNEL TO STAUFFER (UPPER REACH 3,300LF)	30+2+1	200'	–	–	–	–
	STAUFFER TURN BASIN	30+2+1	500' (Diam.)	–	–	–	–
	BRAZOS HARBOR CHNL	No Change	No Change	No Change	No Change	No Change	No Change
	BRAZOS HARBOR TURNING BASIN	No Change	No Change	No Change	No Change	No Change	No Change



US Army Corps of Engineers
Galveston District

Rev.	Description	Date	By

U.S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS

PREPARED UNDER THE DIRECTION OF
DAVID C. WESTON, Col., C.E.,
DISTRICT COMMANDER

Drawn by: X
Designed by: X
Checked by: X
Date: X
Rev.
Scale: AS SHOWN
Submitted by: DAVID R. BROWN, P.E. Chief, General Engineering Section
Approval Recommended: HARRISON T. SUTCLIFFE, P.E. Chief, Engineering Branch
Approved by: PETE G. PEREZ, P.E. Chief, Engineering and Construction Division

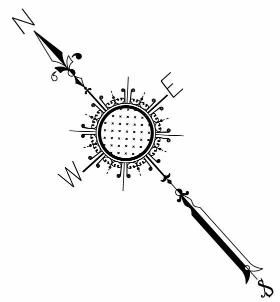
EXISTING PROJECT LAYOUT

Drawing No.: C03

Sheet of X

File No.

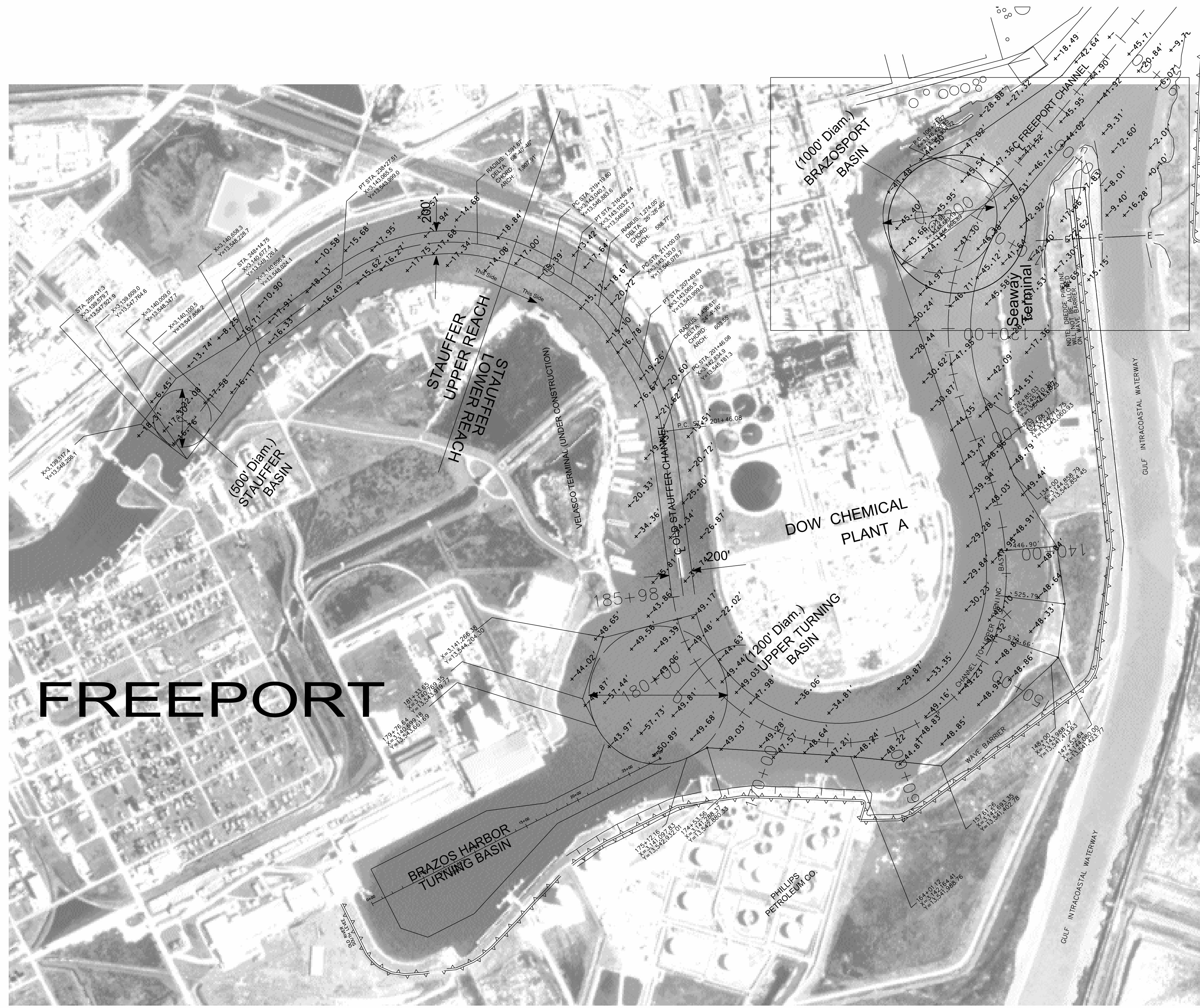
3/1/2010 8:44:03 AM W:\Cadd\Projects\Braz\Frport Nav Study\Latest Freeport\Drawings 24OCT07\EA V8 Frport Plates\C03 Existing Site Plate.dgn



PLAN

SCALE IN FEET

500 0 500 1000



US Army Corps of Engineers
Galveston District

Rev.	Description	Date	By

U.S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS

PREPARED UNDER THE DIRECTION OF
DAVID C. WESTON, Col., C.E.,
DISTRICT COMMANDER

Drawn by: X
Designed by: X
Checked by: X
Submitted by: DAVID P. BROWN, P.E. Chief, General Engineering Section
Approval Recommended: HARRISON I. SUTCLIFFE, P.E. Chief, Engineering Branch
Approved by: PETE G. PEREZ, P.E. Chief, Engineering and Construction Division
Date: X
Scale: AS SHOWN
Rev.

EXISTING ENLARGED+LPP+NED
STAUFFER REACH thru
BRAZOSPORT TURNING BASIN

Drawing No.:

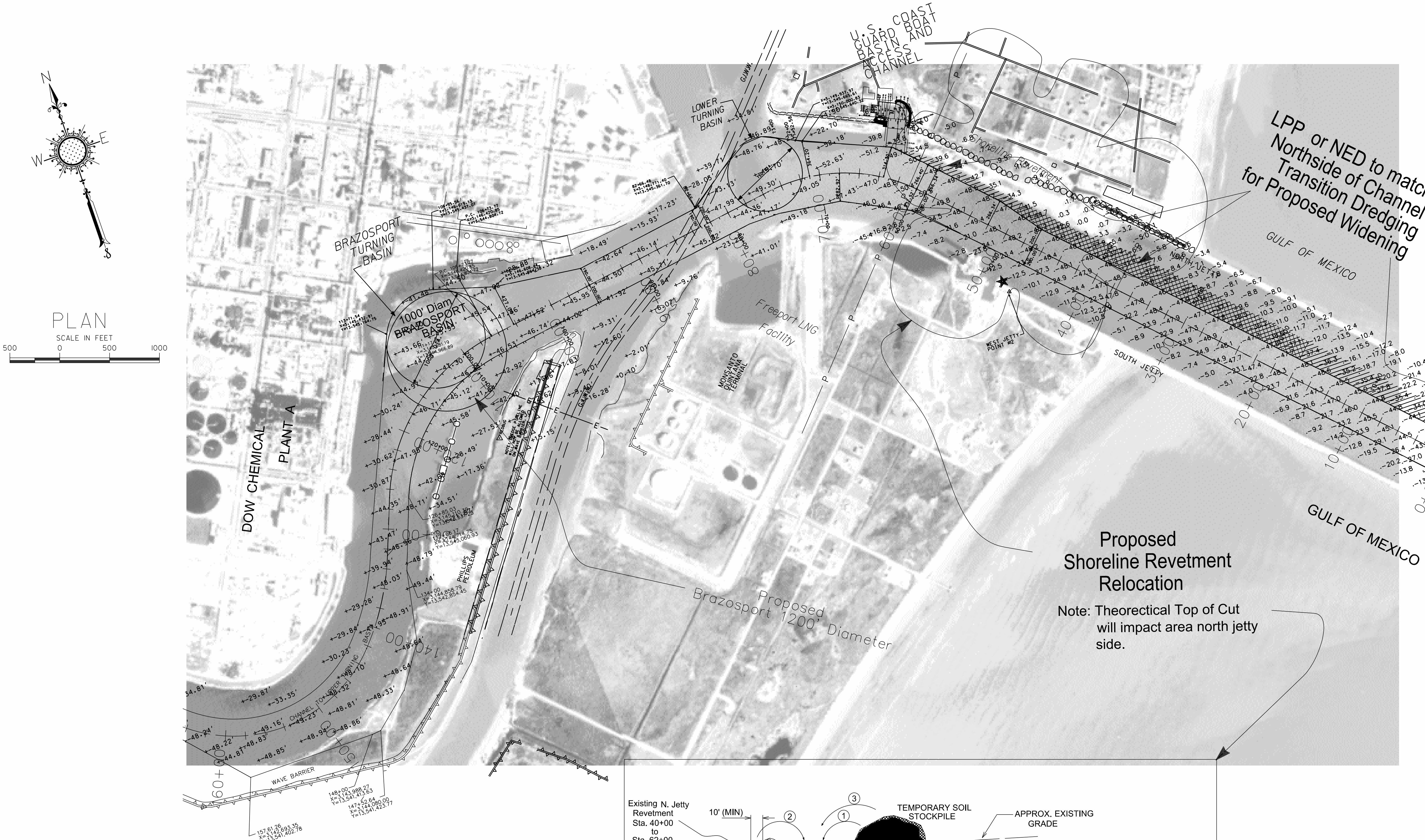
C04

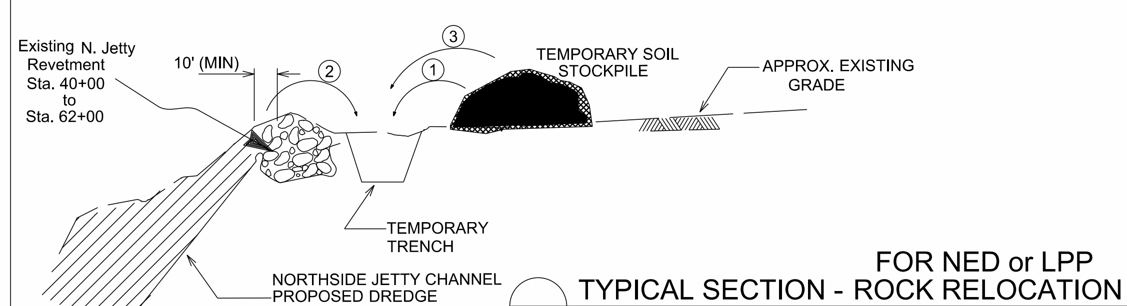
Sheet of X

File No.

US Army Corps of Engineers
Galveston District

Rev.	Description	Date	By





FOR NED or LPP
TYPICAL SECTION - ROCK RELOCATION
SCALE: N.T.S.

Drawn by: X	Dates: X	Rev.
Designed by: X		
Checked by: X	Scales AS SHOWN	
Submitted by: DAVID P. BROWN, P.E. Chief, General Engineering Section	Approval Recommended: HARRISON T. SUTCLIFFE, P.E. Chief, Engineering Branch	
Approved by: PETE G. PEREZ, P.E. Chief, Engineering and Construction Division		

U.S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS

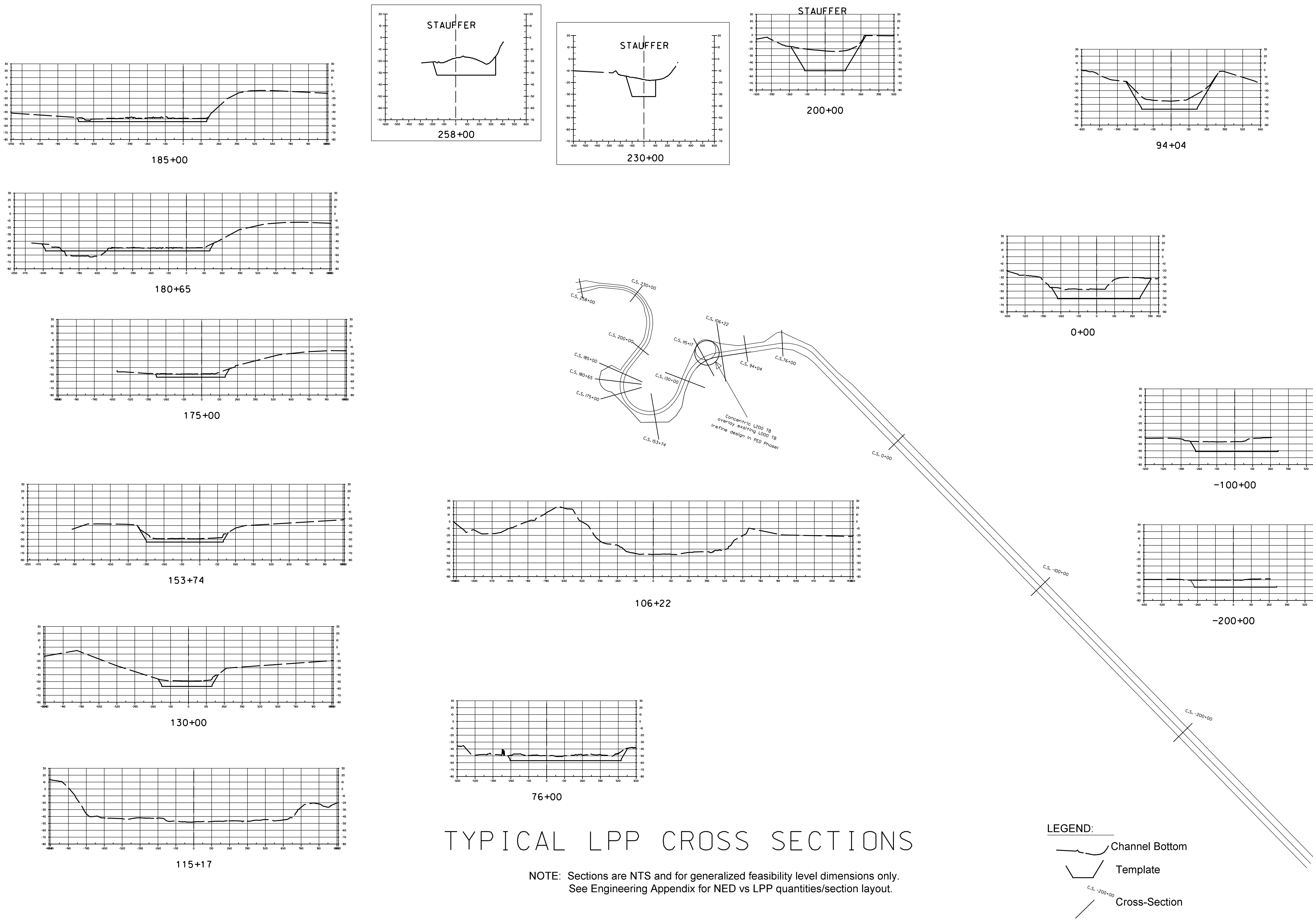
PREPARED UNDER THE DIRECTION OF
DAVID C. WESTON, Col., C.E.,
DISTRICT COMMANDER

EXISTING ENLARGED+LPP+NED
BRAZOSPORT TURNING BASIN
thru JETTY / ENTRANCE CHANNEL

Drawing No.: C05

Sheet of X

File No.



TYPICAL LPP CROSS SECTIONS

NOTE: Sections are NTS and for generalized feasibility level dimensions only.
See Engineering Appendix for NED vs LPP quantities/section layout.

LEGEND:
Channel Bottom
Template
C.S. -200+00 Cross-Section

US Army Corps of Engineers
Galveston District

Drawn by: X
Designed by: X
Checked by: X
Submitted by: DAVID P. BROWN, P.E. Chief, General Engineering Section
Approval Recommended: HARRISON T. SUTCLIFFE, P.E. Chief, Engineering Branch
Approved by: PETE G. PEREZ, P.E. Chief, Engineering and Construction Division
Date: X
Scale: AS SHOWN

U.S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS

PREPARED UNDER THE DIRECTION OF
DAVID C. WESTON, Col., C.E.,
DISTRICT COMMANDER

TYPICAL LPP
CROSS-SECTIONS

Drawing No.: C06
Sheet of X
File No.

Freeport Harbor

Project Name: SWG Channel Alignments
Description: SP83TXSC Alignments
Horizontal Alignment Name: Freeport Harbor
Description: -300+00.000 to 184+19.880

	STATION	NORTHING	EASTING
Element: Linear			
POB ( )	**-300+00.000000**	**13519041.994000**	**3176070.566000**
PC ( )	59+62.884289	13544785.945151	3150959.253299
Tangent Direction:	N 44°17'14.202" W		
Tangent Length:	35962.884289		
Element: Circular			
PC ( )	59+62.884289	13544785.945151	3150959.253299
PI ( )	**68+19.753389**	**13545399.333000**	**3150360.939000**
CC ( )		13543619.107799	3149763.019389
PT ( )	75+46.419878	13545271.471713	3149513.663280
Radius:	**1671.073000**		
Delta:	54°17'39.840" Left		
Degree of Curve:	3°25'43.255"		
Length:	1583.535589		
Tangent:	856.869100		
Chord:	1524.948047		
Middle Ordinate:	184.090036		
External:	206.880574		
Tangent Direction:	N 44°17'14.202" W		
Radial Direction:	N 45°42'45.798" E		
Chord Direction:	N 71°26'04.122" W		
Radial Direction:	N 8°34'54.042" W		
Tangent Direction:	N 81°25'05.958" E		
Element: Linear			
PT ( )	75+46.419878	13545271.471713	3149513.663280
PC ( )	106+74.254903	13544804.738798	3146420.847034
Tangent Direction:	N 81°25'05.958" E		
Tangent Length:	3127.835025		
Element: Circular			
PC ( )	106+74.254903	13544804.738798	3146420.847034
PI ( )	**117+84.439399**	**13544639.078000**	**3145323.092000**
CC ( )		13542916.241532	3146705.837723
PT ( )	126+85.529503	13543603.193141	3144923.777370
Radius:	**1909.880000**		
Delta:	60°20'15.304" Left		
Degree of Cure:	2°59'59.883"		
Length:	2011.274600		
Tangent:	1110.184496		
Chord:	1919.617031		
Middle Ordinate:	258.695810		
External:	299.226432		
Tangent Direction:	N 81°25'05.958" E		
Radial Direction:	N 8°34'54.042" W		

Chord Direction:	N 51°14'58.305" E		
Radial Direction:	N 68°55'09.347" W		
Tangent Direction:	N 21°04'50.653" E		

Element: Linear

PT ( )	126+85.529503	13543603.193141	3144923.777370
PC ( )	132+66.661899	13543060.953313	3144714.753853
Tangent Direction:	N 21°04'50.653" E		
Tangent Length:	581.132396		

Element: Circular

PC ( )	132+66.661899	13543060.953313	3144714.753853
PI ( )	**137+52.719878**	**13542607.425000**	**3144539.927000**
CC ( )		13543996.879739	3142286.813723
PCC ( )	142+27.702283	13542247.590734	3144213.167669
Radius:	**2602.086000**		
Delta:	21°09'40.729" Right		
Degree of Curve:	2°12'06.902"		
Length:	961.040384		
Tangent:	486.057979		
Chord:	955.587455		
Middle Ordinate:	44.242239		
External:	45.007484		
Tangent Direction:	N 21°04'50.653" E		
Radial Direction:	N 68°55'09.347" W		
Chord Direction:	N 31°39'41.018" E		
Radial Direction:	N 47°45'28.618" W		
Tangent Direction:	N 42°14'31.382" E		

Element: Circular

PCC ( )	142+27.702283	13542247.590734	3144213.167669
PI ( )	255+67.283993	13533852.769050	3136589.973965
CC ( )		13543223.825771	3143138.117058
PT ( )	184+19.880284	13543897.655840	3141851.757192
Radius:	**1452.160000**		
Delta:	165°24'16.963" Right		
Degree of Curve:	**3°56'44.000"**		
Length:	**4192.178000**		
Tangent:	11339.581710		
Chord:	2880.794039		
Middle Ordinate:	1267.701085		
External:	9980.026231		
Tangent Direction:	N 42°14'31.382" E		
Radial Direction:	N 47°45'28.618" W		
Chord Direction:	N 55°03'20.136" W		
Radial Direction:	N 62°21'11.655" W		
Tangent Direction:	N 27°38'48.345" E		

```
             Project Name: LPP Map Align
              Description:
Horizontal Alignment Name: LPP Cntrln Mar18
              Description:
                    Style: Default
                                       STATION      NORTHING       EASTING

Element: Linear
             POB (        )          -433+14.00   13509468.42    3185589.72
              PC (        )            60+81.63   13544828.57    3151099.30
         Tangent Direction:       N 44^17'12" W
            Tangent Length:            49395.63

Non-collinear

Element: Circular
              PC (        )            60+81.63   13544828.57    3151099.30
              PI (        )            69+69.41   13545370.24    3150395.93
              CC (        )                       13543087.16    3149758.25
              PT (        )            77+69.10   13545271.45    3149513.66
                    Radius:             2197.94
                     Delta:           43^59'20" Left
  Degree of Curvature(Arc):            2^36'24"
                    Length:             1687.47
                   Tangent:              887.78
                     Chord:             1646.33
          Middle Ordinate:               159.97
                  External:              172.52
         Tangent Direction:       N 52^24'00" W
          Radial Direction:       N 37^36'00" E
           Chord Direction:       N 74^23'40" W
          Radial Direction:       N  6^23'20" W
         Tangent Direction:       S 83^36'40" W

Non-collinear

Element: Linear
              PT (        )            77+69.10   13545271.45    3149513.66
              PI (        )            95+22.99   13545009.73    3147779.41
         Tangent Direction:       S 81^25'06" W
            Tangent Length:             1753.89

Element: Linear
              PI (        )            95+22.99   13545009.73    3147779.41
              PI (        )           108+96.93   13544804.72    3146420.85
         Tangent Direction:       S 81^25'07" W
            Tangent Length:             1373.94

Element: Linear
              PI (        )           108+96.93   13544804.72    3146420.85
              PC (        )           108+96.94   13544804.72    3146420.85
         Tangent Direction:       S 39^31'29" E
            Tangent Length:                0.00

Non-collinear

Element: Circular
              PC (        )           108+96.94   13544804.72    3146420.85
              PI (        )           120+07.13   13544639.06    3145323.09
              CC (        )                       13542916.21    3146705.84
              PT (        )           129+08.22   13543603.17    3144923.77
                    Radius:             1909.89
                     Delta:           60^20'15" Left
  Degree of Curvature(Arc):            3^00'00"
                    Length:             2011.28
                   Tangent:             1110.19
                     Chord:             1919.63
          Middle Ordinate:               258.70
                  External:              299.23
         Tangent Direction:       S 81^25'07" W
          Radial Direction:       N  8^34'53" W
           Chord Direction:       S 51^14'59" W
          Radial Direction:       N 68^55'09" W
         Tangent Direction:       S 21^04'51" W

Non-collinear

Element: Linear
              PT (        )           129+08.22   13543603.17    3144923.77
              PI (        )           129+08.22   13543603.17    3144923.77
         Tangent Direction:       S 47^31'20" W
            Tangent Length:                0.00

Element: Linear
              PI (        )           129+08.22   13543603.17    3144923.77
              PI (        )           134+89.36   13543060.93    3144714.75
         Tangent Direction:       S 21^04'49" W
            Tangent Length:              581.13

Element: Linear
              PI (        )           134+89.36   13543060.93    3144714.75
              PC (        )           134+89.36   13543060.93    3144714.75
         Tangent Direction:       N 66^04'02" W
            Tangent Length:                0.00

Non-collinear

Element: Circular
              PC (        )           134+89.36   13543060.93    3144714.75
              PI (        )           139+75.41   13542607.40    3144539.93
              CC (        )                       13543996.83    3142286.80
              PT (        )           144+50.40   13542247.56    3144213.17
                    Radius:             2602.09
                     Delta:           21^09'41" Right
  Degree of Curvature(Arc):            2^12'07"
                    Length:              961.04
                   Tangent:              486.06
                     Chord:              955.59
          Middle Ordinate:                44.24
                  External:               45.01
         Tangent Direction:       S 21^04'48" W
          Radial Direction:       N 68^55'12" W
           Chord Direction:       S 31^39'38" W
          Radial Direction:       N 47^45'31" W
         Tangent Direction:       S 42^14'29" W

Non-collinear

Element: Linear
              PT (        )           144+50.40   13542247.56    3144213.17
              PC (        )           144+50.40   13542247.56    3144213.17
         Tangent Direction:       S 26^21'27" W
```

```
           Tangent Length:                0.00

Non-collinear

Element: Circular
              PC (        )          144+50.40   13542247.56    3144213.17
              PI (        )          364+09.43   13525990.70    3129451.27
              CC (        )                      13543223.77    3143138.10
              PT (        )          188+20.70   13544049.91    3141943.84
                    Radius:            1452.16
                     Delta:          172^25'59" Right
  Degree of Curvature(Arc):            3^56'44"
                    Length:            4370.31
                   Tangent:           21959.04
                     Chord:            2897.99
           Middle Ordinate:            1356.34
                  External:           20554.84
         Tangent Direction:       S 42^14'27" W
          Radial Direction:       N 47^45'33" W
           Chord Direction:       N 51^32'34" W
          Radial Direction:       S 55^19'34" E
         Tangent Direction:       N 34^40'26" E

Non-collinear

Element: Linear
              PT (        )          188+20.70   13544049.91    3141943.84
              PC (        )          202+75.07   13545193.01    3142843.02
         Tangent Direction:       N 38^11'22" E
           Tangent Length:             1454.37

Non-collinear

Element: Circular
              PC (        )          202+75.07   13545193.01    3142843.02
              PI (        )          205+75.21   13545438.26    3143016.03
              CC (        )                      13545951.30    3141768.05
              PT (        )          208+65.25   13545734.29    3143065.54
                    Radius:            1315.52
                     Delta:           25^42'15" Left
  Degree of Curvature(Arc):            4^21'19"
                    Length:             590.17
                   Tangent:             300.14
                     Chord:             585.24
           Middle Ordinate:              32.96
                  External:              33.80
         Tangent Direction:       N 35^11'58" E
          Radial Direction:       S 54^48'02" E
           Chord Direction:       N 22^20'50" E
          Radial Direction:       S 80^30'18" E
         Tangent Direction:       N  9^29'42" E

Non-collinear

Element: Linear
              PT (        )          208+65.25   13545734.29    3143065.54
              PC (        )          212+15.69   13546078.74    3143130.02
         Tangent Direction:       N 10^36'10" E
           Tangent Length:              350.44

Non-collinear

Element: Circular
              PC (        )          212+15.69   13546078.74    3143130.02
              PI (        )          216+31.58   13546491.71    3143179.23
              CC (        )                      13546288.99    3141365.43
             PCC (        )          220+32.76   13546883.63    3143040.06
                    Radius:            1777.07
                     Delta:           26^20'38" Left
  Degree of Curvature(Arc):            3^13'27"
                    Length:             817.08
                   Tangent:             415.89
                     Chord:             809.90
           Middle Ordinate:              46.75
                  External:              48.02
         Tangent Direction:       N  6^47'41" E
          Radial Direction:       S 83^12'19" E
           Chord Direction:       N  6^22'39" W
          Radial Direction:       N 70^27'02" E
         Tangent Direction:       N 19^32'58" W

Non-collinear

Element: Circular
             PCC (        )          220+32.76   13546883.63    3143040.06
              PI (        )          231+20.14   13547929.54    3142742.62
              CC (        )                      13546448.25    3141509.10
              PT (        )          239+40.67   13548032.73    3141660.14
                    Radius:            1591.67
                     Delta:           68^40'46" Left
  Degree of Curvature(Arc):            3^35'59"
                    Length:            1907.91
                   Tangent:            1087.38
                     Chord:            1795.72
           Middle Ordinate:             277.42
                  External:             335.97
         Tangent Direction:       N 15^52'30" W
          Radial Direction:       N 74^07'30" E
           Chord Direction:       N 50^12'53" W
          Radial Direction:       N  5^26'44" E
         Tangent Direction:       N 84^33'16" W

Non-coincident

Element: Linear
              PT (        )          239+40.67   13548032.73    3141660.14
              PI (        )          249+27.91   13548126.42    3140677.36
         Tangent Direction:       N 84^33'16" W
           Tangent Length:              987.24

Element: Linear
              PI (        )          249+27.91   13548126.42    3140677.36
             POE (        )          260+44.46   13547921.90    3139579.70
         Tangent Direction:       S 79^26'44" W
           Tangent Length:             1116.55
```

```
            Project Name: NED Map Jul19
             Description:
Horizontal Alignment Name: NED Cntrln Mar18
             Description:
                   Style: Default
                                      STATION      NORTHING       EASTING

Element: Linear
            POB (        )         -433+14.00   13509441.55    3185562.16
             PC (        )           57+41.59   13544557.88    3151308.78
        Tangent Direction:      N 44^17'14" W
           Tangent Length:           49055.59

Element: Circular
             PC (        )           57+41.59   13544557.88    3151308.78
             PI (        )           67+48.57   13545278.73    3150605.65
             CC (        )                      13542882.06    3149590.75
            PCC (        )           76+48.48   13545282.06    3149598.67
                   Radius:            2400.00
                    Delta:          45^31'24" Left
  Degree of Curvature(Arc):           2^23'14"
                   Length:            1906.89
                  Tangent:            1006.98
                    Chord:            1857.12
          Middle Ordinate:             186.91
                 External:             202.69
        Tangent Direction:      N 44^17'14" W
         Radial Direction:      N 45^42'46" E
          Chord Direction:      N 67^02'56" W
         Radial Direction:      N  0^11'21" E
        Tangent Direction:      N 89^48'39" W

Non-collinear

Element: Circular
            PCC (        )           76+48.48   13545282.06    3149598.67
             PI (        )           76+91.33   13545277.84    3149556.03
             CC (        )                      13543619.09    3149763.02
             PT (        )           77+34.16   13545271.45    3149513.66
                   Radius:            1671.07
                    Delta:           2^56'16" Left
  Degree of Curvature(Arc):           3^25'43"
                   Length:              85.68
                  Tangent:              42.85
                    Chord:              85.67
          Middle Ordinate:               0.55
                 External:               0.55
        Tangent Direction:      S 84^21'22" W
         Radial Direction:      N  5^38'38" W
          Chord Direction:      S 82^53'14" W
         Radial Direction:      N  8^34'54" W
        Tangent Direction:      S 81^25'06" W

Non-collinear

Element: Linear
             PT (        )           77+34.16   13545271.45    3149513.66
             PI (        )           94+88.05   13545009.73    3147779.41
        Tangent Direction:      S 81^25'06" W
           Tangent Length:            1753.89

Element: Linear
             PI (        )           94+88.05   13545009.73    3147779.41
             PI (        )          108+61.99   13544804.72    3146420.85
        Tangent Direction:      S 81^25'07" W
           Tangent Length:            1373.94

Element: Linear
             PI (        )          108+61.99   13544804.72    3146420.85
             PC (        )          108+61.99   13544804.72    3146420.85
        Tangent Direction:      S 39^31'29" E
           Tangent Length:               0.00

Non-collinear

Element: Circular
             PC (        )          108+61.99   13544804.72    3146420.85
             PI (        )          119+72.18   13544639.06    3145323.09
             CC (        )                      13542916.21    3146705.84
             PT (        )          128+73.28   13543603.17    3144923.77
                   Radius:            1909.89
                    Delta:          60^20'15" Left
  Degree of Curvature(Arc):           3^00'00"
                   Length:            2011.28
                  Tangent:            1110.19
                    Chord:            1919.63
          Middle Ordinate:             258.70
                 External:             299.23
        Tangent Direction:      S 81^25'07" W
         Radial Direction:      N  8^34'53" W
          Chord Direction:      S 51^14'59" W
         Radial Direction:      N 68^55'09" W
        Tangent Direction:      S 21^04'51" W

Non-collinear

Element: Linear
             PT (        )          128+73.28   13543603.17    3144923.77
             PI (        )          128+73.28   13543603.17    3144923.77
        Tangent Direction:      S 47^31'20" W
           Tangent Length:               0.00

Element: Linear
             PI (        )          128+73.28   13543603.17    3144923.77
             PI (        )          134+54.41   13543060.93    3144714.75
        Tangent Direction:      S 21^04'49" W
           Tangent Length:             581.13

Element: Linear
             PI (        )          134+54.41   13543060.93    3144714.75
             PC (        )          134+54.41   13543060.93    3144714.75
        Tangent Direction:      N 66^04'02" W
           Tangent Length:               0.00

Non-collinear

Element: Circular
             PC (        )          134+54.41   13543060.93    3144714.75
             PI (        )          139+40.47   13542607.40    3144539.93
             CC (        )                      13543996.83    3142286.80
             PT (        )          144+15.45   13542247.56    3144213.17
                   Radius:            2602.09
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                 Delta:          21^09'41" Right
  Degree of Curvature(Arc):        2^12'07"
                Length:            961.04
               Tangent:            486.06
                 Chord:            955.59
        Middle Ordinate:            44.24
              External:             45.01
       Tangent Direction:      S 21^04'48" W
        Radial Direction:      N 68^55'12" W
         Chord Direction:      S 31^39'38" W
        Radial Direction:      N 47^45'31" W
       Tangent Direction:      S 42^14'29" W

Non-collinear

Element: Linear
              PT (        )          144+15.45   13542247.56    3144213.17
              PC (        )          144+15.45   13542247.56    3144213.17
       Tangent Direction:      S 26^21'27" W
          Tangent Length:                 0.00

Non-collinear

Element: Circular
              PC (        )          144+15.45   13542247.56    3144213.17
              PI (        )          363+74.49   13525990.70    3129451.27
              CC (        )                      13543223.77    3143138.10
              PT (        )          187+85.76   13544049.91    3141943.84
                Radius:           1452.16
                 Delta:        172^25'59" Right
  Degree of Curvature(Arc):        3^56'44"
                Length:           4370.31
               Tangent:          21959.04
                 Chord:           2897.99
        Middle Ordinate:          1356.34
              External:          20554.84
       Tangent Direction:      S 42^14'27" W
        Radial Direction:      N 47^45'33" W
         Chord Direction:      N 51^32'34" W
        Radial Direction:      S 55^19'34" E
       Tangent Direction:      N 34^40'26" E

Non-collinear

Element: Linear
              PT (        )          187+85.76   13544049.91    3141943.84
              PC (        )          202+40.13   13545193.01    3142843.02
       Tangent Direction:      N 38^11'22" E
          Tangent Length:              1454.37

Non-collinear

Element: Circular
              PC (        )          202+40.13   13545193.01    3142843.02
              PI (        )          205+40.26   13545438.26    3143016.03
              CC (        )                      13545951.30    3141768.05
              PT (        )          208+30.30   13545734.29    3143065.54
                Radius:           1315.52
                 Delta:         25^42'15" Left
  Degree of Curvature(Arc):        4^21'19"
                Length:            590.17
               Tangent:            300.14
                 Chord:            585.24
        Middle Ordinate:            32.96
              External:             33.80
       Tangent Direction:      N 35^11'58" E
        Radial Direction:      S 54^48'02" E
         Chord Direction:      N 22^20'50" E
        Radial Direction:      S 80^30'18" E
       Tangent Direction:      N  9^29'42" E

Non-collinear

Element: Linear
              PT (        )          208+30.30   13545734.29    3143065.54
              PC (        )          211+80.74   13546078.74    3143130.02
       Tangent Direction:      N 10^36'10" E
          Tangent Length:               350.44

Non-collinear

Element: Circular
              PC (        )          211+80.74   13546078.74    3143130.02
              PI (        )          215+96.63   13546491.71    3143179.23
              CC (        )                      13546288.99    3141365.43
             PCC (        )          219+97.82   13546883.63    3143040.06
                Radius:           1777.07
                 Delta:         26^20'38" Left
  Degree of Curvature(Arc):        3^13'27"
                Length:            817.08
               Tangent:            415.89
                 Chord:            809.90
        Middle Ordinate:            46.75
              External:             48.02
       Tangent Direction:      N  6^47'41" E
        Radial Direction:      S 83^12'19" E
         Chord Direction:      N  6^22'39" W
        Radial Direction:      N 70^27'02" E
       Tangent Direction:      N 19^32'58" W

Non-collinear

Element: Circular
             PCC (        )          219+97.82   13546883.63    3143040.06
              PI (        )          230+85.20   13547929.54    3142742.62
              CC (        )                      13546448.25    3141509.10
              PT (        )          239+05.72   13548032.73    3141660.14
                Radius:           1591.67
                 Delta:         68^40'46" Left
  Degree of Curvature(Arc):        3^35'59"
                Length:           1907.91
               Tangent:           1087.38
                 Chord:           1795.72
        Middle Ordinate:           277.42
              External:            335.97
       Tangent Direction:      N 15^52'30" W
        Radial Direction:      N 74^07'30" E
         Chord Direction:      N 50^12'53" W
        Radial Direction:      N  5^26'44" E
       Tangent Direction:      N 84^33'16" W

Non-coincident
```

```
Element: Linear
            PT (        )          239+05.72   13548032.73    3141660.14
            PI (        )          248+92.96   13548126.42    3140677.36
        Tangent Direction:      N 84^33'16" W
           Tangent Length:            987.24

Element: Linear
            PI (        )          248+92.96   13548126.42    3140677.36
           POE (        )          260+09.51   13547921.90    3139579.70
        Tangent Direction:      S 79^26'44" W
           Tangent Length:           1116.55
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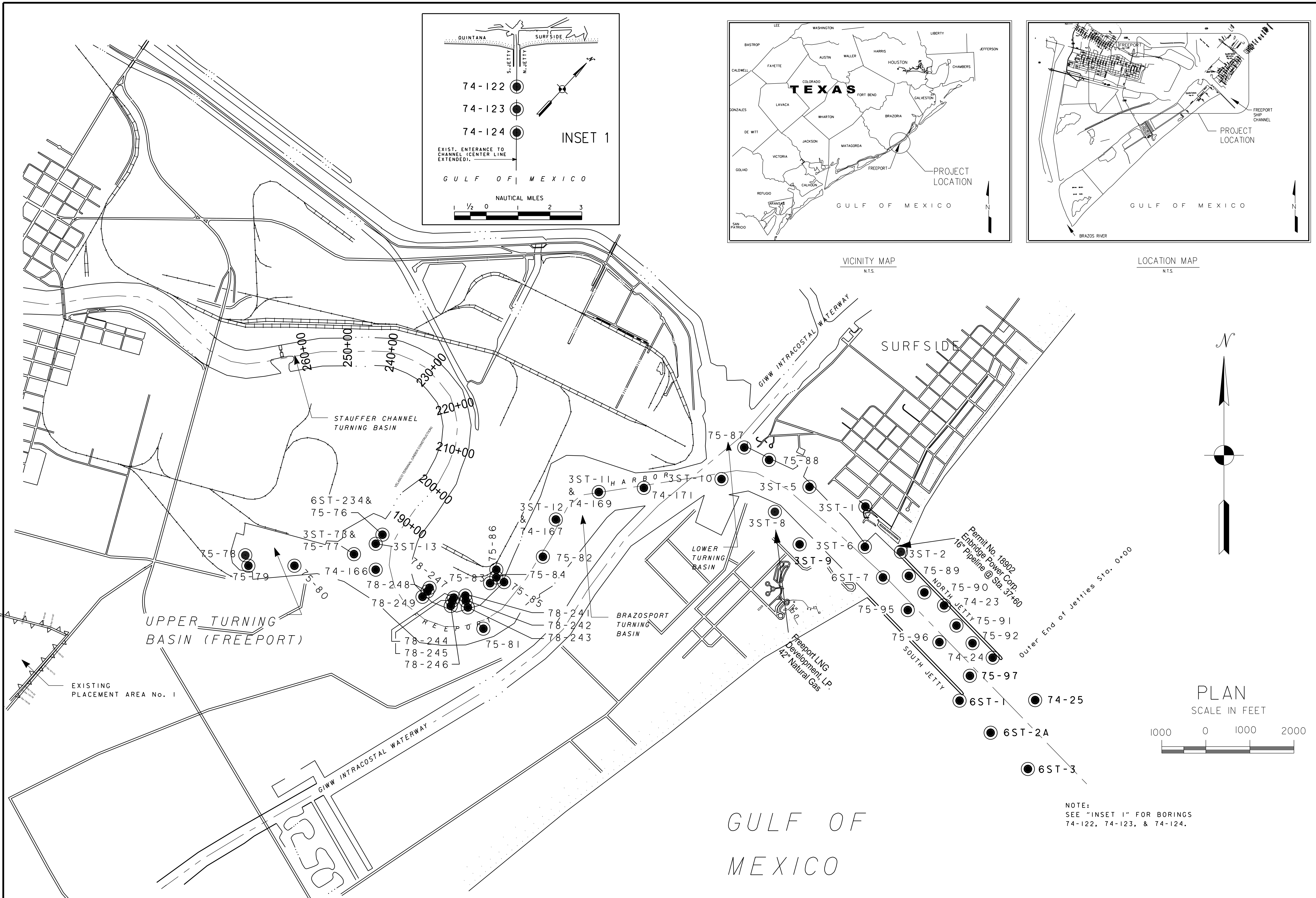


US Army Corps of Engineers
Galveston District

Rev.	Description	Date	By

Drawn by: PN & RB	Date: MARCH 2008
Designed by: RB	Rev.
Checked by: RB	Scale: AS SHOWN
Submitted by: LORI K. THOMAS, P.E. Chief, Geotech/Structure Section	Approval Recommended: HARRISON T. SUTCLIFFE, P.E. Chief, Engineering Branch
Approved by: PETE G. PEREZ, P.E. Chief, Engineering and Construction Division	

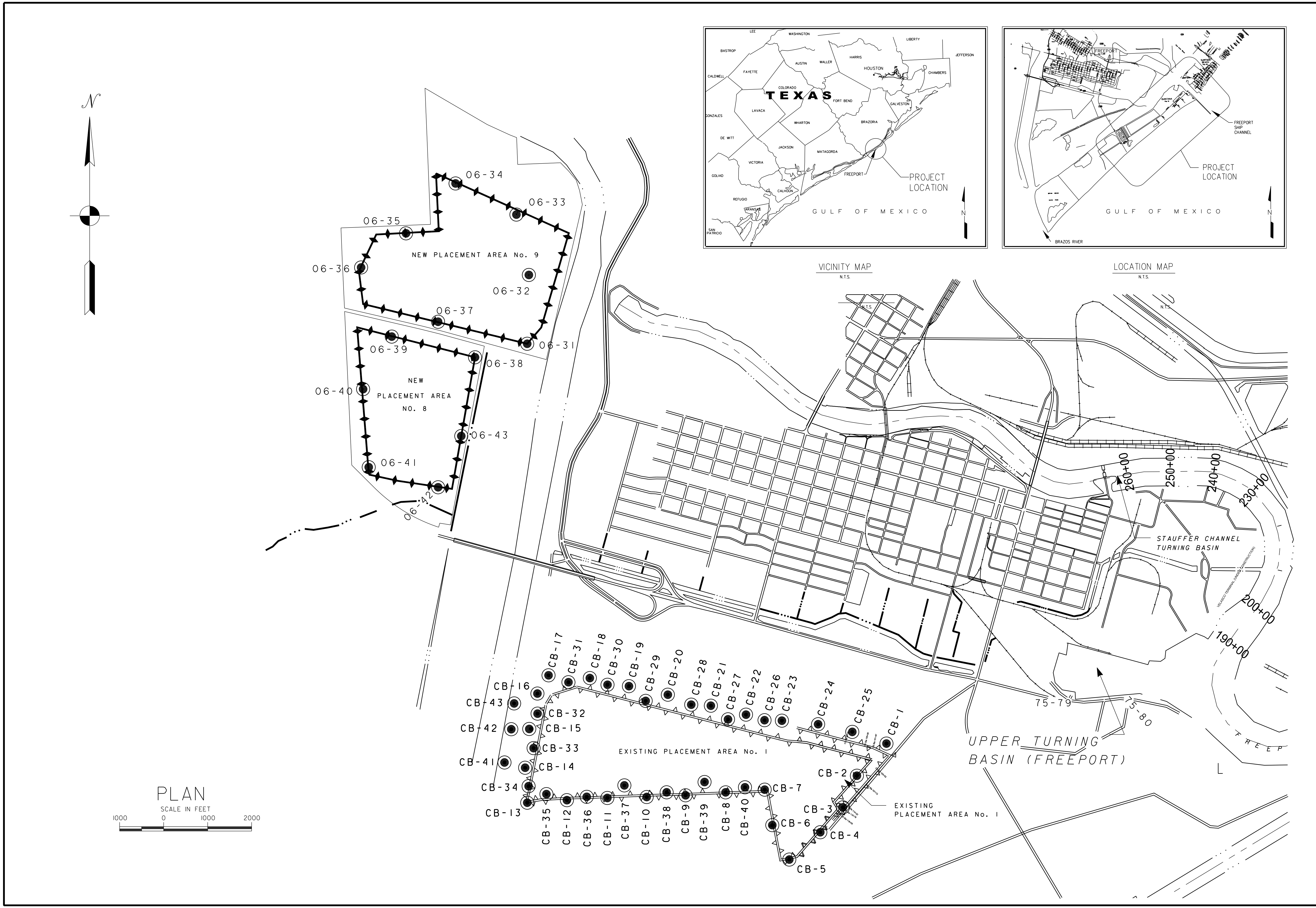
U.S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS

PREPARED UNDER THE DIRECTION OF
DAVID C. WESTON, Col., C.E.,
DISTRICT ENGINEER

FREEPORT HARBOR NAVIGATION STUDY

PLAN
FREEPORT CHANNEL
BORING LOCATIONS

Drawing No.: F-01
Sheet of X
File No.



US Army Corps of Engineers
Galveston District

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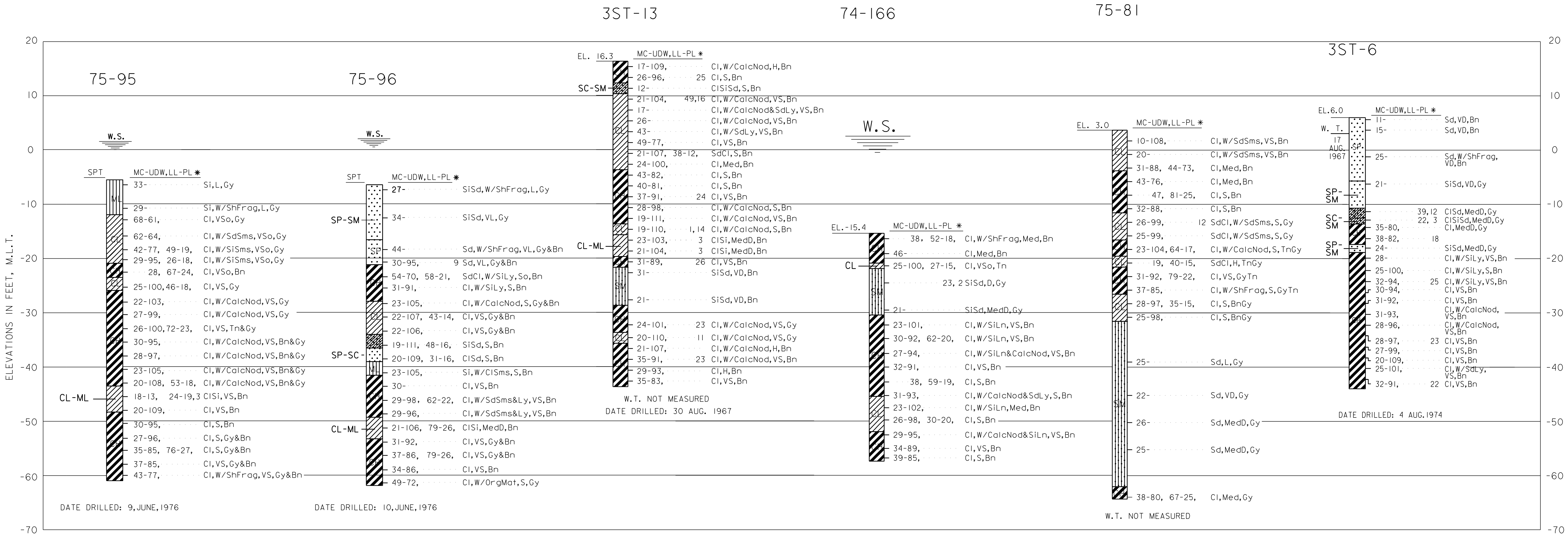
U.S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS

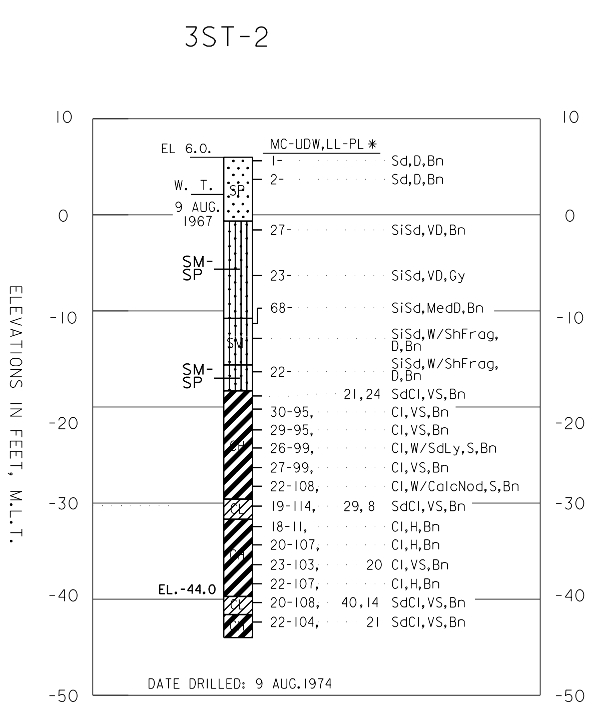
PREPARED UNDER THE DIRECTION OF
DAVID C. WESTON, Col., C.E.,
DISTRICT ENGINEER

Drawn by: PN & RB
Designed by: RB
Checked by: RB
Date: MARCH 2008
Rev.
Scale: AS SHOWN
Submitted by: LORI K. THOMAS, P.E. Chief, Geotech/Structure Section
Approval Recommended: HARRISON T. SUTCLIFFE, P.E. Chief, Engineering Branch
Approved by: PETE G. PEREZ, P.E. Chief, Engineering and Construction Division

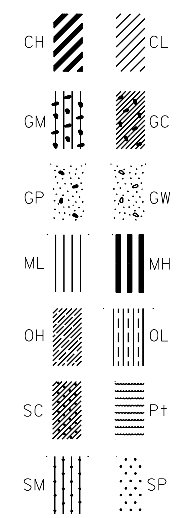
FREEPORT HARBOR NAVIGATION STUDY
PLAN
PA 1, 8, & 9
BORING LOCATIONS

Drawing No.:
F-02
Sheet of X
File No.





LABORATORY CLASSIFICATIONS:



CH INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS.
CL INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, LEAN CLAYS.
GC CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES.
GM SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES.
GP POORLY-GRADED GRAVELS OR GRAVEL-SAND MIXTURES, LITTLE OR NO FINES.
GW WELL-GRADED GRAVELS OR GRAVEL-SAND MIXTURES, LITTLE OR NO FINES.
MH INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS, ELASTIC SILTS.
ML INORGANIC SILTS AND VERY FINE SANDS, WITH SLIGHT PLASTICITY.
OH ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS.
OL ORGANIC SILTS, AND ORGANIC SILT-CLAYS OF LOW PLASTICITY.
Pt PEAT AND OTHER HIGHLY ORGANIC SOILS.
SC CLAYEY SANDS, SAND-CLAY MIXTURES.
SM SILTY SANDS, SAND-SILT MIXTURES.
SP POORLY GRADED SANDS OR GRAVELLY SANDS, LITTLE OR NO FINES.
SW WELL-GRADED SANDS OR GRAVELLY SANDS, LITTLE OR NO FINES.
CL-ML OR ML-CL CLAY AND SILT MIXTURES WITH SLIGHT PLASTICITY
SP-SM OR SM-SP SLIGHTLY SILTY SANDS, SANDS WITH SOME SILTS
SM-SC OR SC-SM SLIGHTLY SILTY AND CLAYEY SANDS, SANDS WITH SOME SILTS AND CLAYS

NOTES;

1. SOILS HAVE BEEN CLASSIFIED IN ACCORDANCE WITH ASTM 2487 "CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES (UNIFIED SOILS CLASSIFICATION SYSTEM)". CONSISTENCY OF SOILS SUCH AS SOFT, MEDIUM, HARD, LOOSE, DENSE, ETC., ARE RELATIVE TERMS BASED ON ESTIMATED UNDISTURBED SHEAR STRENGTH OF THE MATERIAL AS DETERMINED BY VISUAL CLASSIFICATION POCKET PENETROMETER TESTS AND PENETRATION RESISTANCE DURING SAMPLING.
2. FIGURES TO THE RIGHT OF BORING LOGS ARE WATER CONTENTS IN PERCENT OF THE DRY WEIGHT, DRY DENSITY, LIQUID LIMIT, PLASTIC LIMIT, AND BAR LINEAR SHRINKAGE. (MC-UDW),(LL-PL),(B.L.S.)* FIGURES TO THE LEFT OF BORING LOGS UNDER COLUMN HEADING ENTITLED "SPT"ARE BLOWS PER FOOT OF PENETRATION FROM STANDARD PENETRATION TESTING. FIGURES BELOW COLUMN HEADINGS "P.P." AND "T." ARE POCKET PENETROMETER AND TORVANE TESTS RESPECTIVELY IN UNITS OF TONS PER SQUARE FEET.
3. BORINGS WERE DRILLED USING WET ROTARY DRILLING TECHNIQUES AND UNDISTURBED SAMPLES WERE RECOVERED WITH A 3-INCH DIAMETER THIN WALL SAMPLER WHERE COHESIVE MATERIALS WERE ENCOUNTERED.WHERE COHESIONLESS MATERIALS WERE ENCOUNTERED, DISTURBED SAMPLES WERE TAKEN WITH A SPLIT SPOON SAMPLER DURING PERFORMANCE OF STANDARD PENETRATION TESTING.
4. WATER LEVELS SHOWN ON BORING LOGS WERE DETERMINED AFTER DRILLING BORINGS BY MEASURING THE TOP OF FLUID LEVELS IN THE BORINGS. IN AS MUCH AS WET ROTERY DRILLING TECHNIQUES AND DRILLING MUD WERE USED TO DRILL THE HOLES, THE LEVEL OF DRILLING HOLES MAY NOT HAVE STABLILIZED TO THE LEVEL OF THE ACTUAL WATER TABLE. ADDITIONALLY, WATER TABLES IN THE FIELD ARE LIKELY TO FLUCTUATE DEPENDING ON WEATHER CONDITIONS. THEREFORE, SOME VARIATION SHOULD BE ANTICIPATED BETWEEN WATER TABLES INDICATED AND WATER TABLES ENCOUNTERED IN THE FIELD.

VISUAL CLASSIFICATIONS:

Asph Asphalt
Agg Aggerate
Ba Ball(s)
Bin Binder
Bl Black
Blk Blockey
Blu Blue
Bn Brown(ish)
Br Brick
Bs Base
Bu Buff
Calc Calcareous
Cem Cement(ed)
Chem Chemical

Cl Clay(ey)
Cli Caliche
Coa Coarse
Conc Concrete
Coq Coquins
Ch Chert
D-Odr Distinct Odor
D Dense
Db Debris
D.C. Driller's Classification
Dec Decay(ed)
Dep Deposit(s)

Dk Dark
Dr Dredge
F Firm
Fer Ferrous
Fi Fine(s)
Fl Fill
Fk Flake(s)
Frag Fragment(s)
Fri Friable
Gl Glass
Gra Grass
Gr Green(ish)
Gv Gravel(ly)
Gy Gray(ish)

Gyp Gypsum
H Hard
Hcbn Hydrocarben
Hi Highly
Ind Industrial
Inor Inorganic
Ir Iron
L Loose
Lg Large
Lim Limonites
Ln Lense(s)
Lp Lump(s)
Ly Layer(s)
Lims Limestone

Lt Light
Meas Measured
Ma Matter
Mat Material
Med Medium
Mu Muck
Mar Marsh
Mot Mottled
Nod Nodules
N.T. No Test
Nt Not
N.Rec No Recovery
Org Organic
Ol Olive

Part Particle(s)
Peb Pebble(s)
Pet Petroleum
Pl Plant
Poc Pocket(s)
Prt Parting(s)
Pt Peat
Rd Road
RdBd Road Bed

Rec Recorded
R Red(dish)
Rk Rock(s)
Rts Root(s)
Rub Rubble
Ref Refinery
S Stiff
Sd Sand(y)
Sl Shale

Sh Shell(y)
Si Silty
Sli Slighty
Slks Slicken Sides
Sm Small
Sms Seams
So Soft
St Stone(s)
Sur Surface

T.D. Total Depth
Th Thin
Tk Thick
Tn Tan(nish)
Tr Trace(s)
Unde Undetermined
V Very
Veg Vegetation
Vert Vertical

Wa Waste
Wd Wood(en)
Wh White
Wea Weathered
W.T. Water Table
W.S. Water Surface
W With
Y Yellow(ish)

US Army Corps of Engineers
Galveston District

Rev. | Date | By | Description

U.S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS

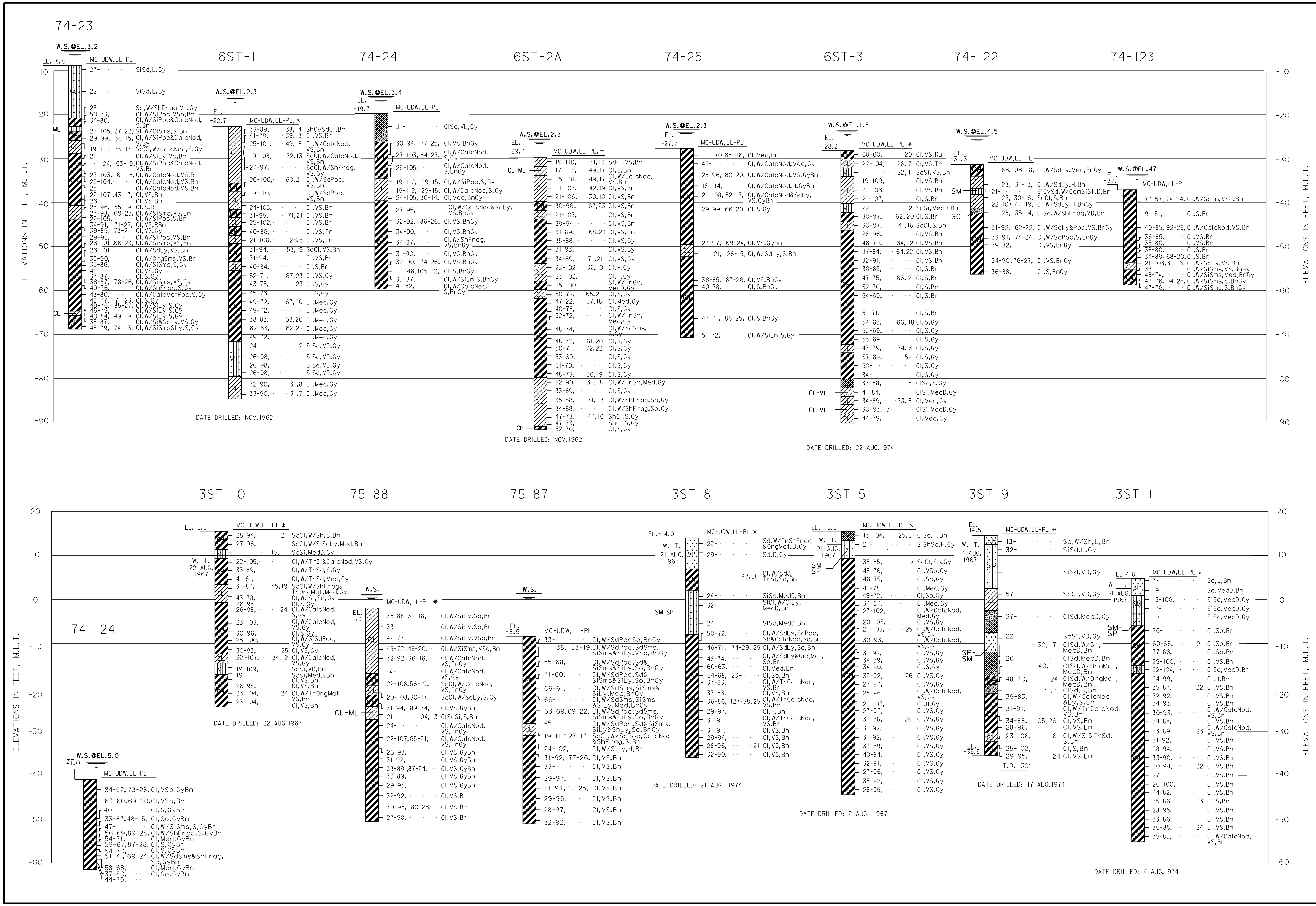
PREPARED UNDER THE DIRECTION OF
DAVID C. WESTON, Col., C.E.,
DISTRICT ENGINEER

Drawn by: PN & RB
Designed by: RB
Checked by: RB
Submitted by: LORI K. THOMAS, P.E. Chief, Geotech/Structure Section
Approved by: PETE G. PEREZ, P.E. Chief, Engineering and Construction Division
Date: MARCH 2008
Rev.
Scale: AS SHOWN
Approval Recommended: HARRISON T. SUTCLIFFE, P.E. Chief, Engineering Branch

FREEPORT HARBOR NAVIGATION STUDY

FREEPORT CHANNEL
LOG OF BORINGS

Drawing No.:
F-03
Sheet of X
File No.



US Army Corps of Engineers
Galveston District

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Drawn by: PN & RB
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U.S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS

PREPARED UNDER THE DIRECTION OF
DAVID C. WESTON, Col., C.E.,
DISTRICT ENGINEER

FREEPORT HARBOR NAVIGATION STUDY

FREEPORT CHANNEL
LOG OF BORINGS

Drawing No.:
F-04

Sheet of X

File No.

US Army Corps of Engineers
Galveston District

Rev.	Description	Date	By

Drawn by: PN & RB
Designed by: RB
Checked by: RB
Submitted by: LORI K. THOMAS, P.E. Chief, Geotech/Structure Section
Approval Recommended: HARRISON T. SUTCLIFFE, P.E. Chief, Engineering Branch
Approved by: PETE G. PEREZ, P.E. Chief, Engineering and Construction Division
Date: MARCH 2008
Scales: AS SHOWN

U.S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS

PREPARED UNDER THE DIRECTION OF
DAVID C. WESTON, Col., C.E.,
DISTRICT ENGINEER

FREEPORT HARBOR NAVIGATION STUDY

FREEPORT CHANNEL
LOG OF BORINGS

Drawing No.:
F-05

Sheet of X

File No.

NOTE:
SEE DRAWING F-07 FOR BORING NOTES AND LEGEND.

US Army Corps of Engineers
Galveston District

Rev. | Description | Date | By

Drawn by: PN & RB
Designed by: RB
Checked by: RB
Date: MARCH 2008
Scale: AS SHOWN
Rev.: —
Submitted by: LORI K. THOMAS, P.E., Chief, Geotech/Structures Section
Approval/Recommended: HARRISON T. SUTCLIFFE, P.E., Chief, Engineering Branch
Approved by: PETE G. PEREZ, P.E., Chief, Engineering and Construction Division

U.S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS

PREPARED UNDER THE DIRECTION OF
DAVID C. WESTON, Col., C.E.,
DISTRICT ENGINEER

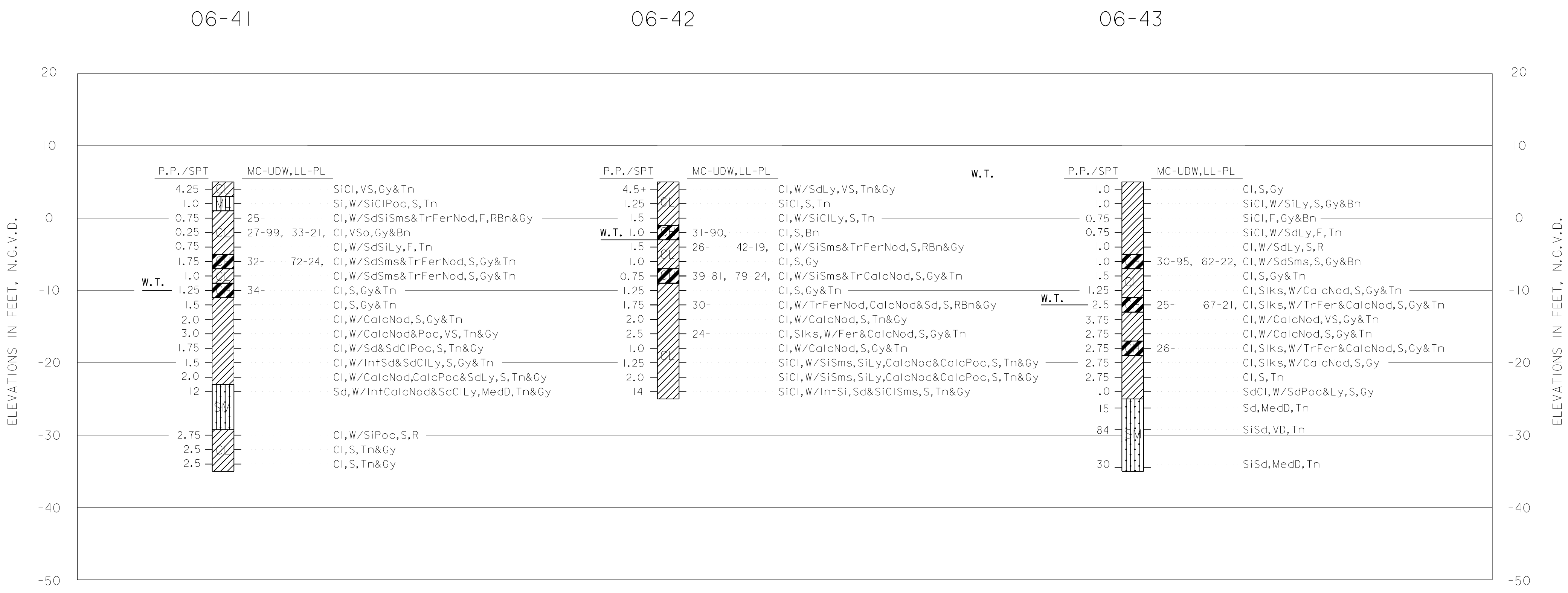
FREEPORT HARBOR NAVIGATION STUDY

PLACEMENT AREA 8 & 9
LOG OF BORINGS

Drawing No.:
F-06

Sheet of X

File No.



NOTES;

1. SOILS HAVE BEEN CLASSIFIED IN ACCORDANCE WITH ASTM D-2487-93 "CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES (UNIFIED SOIL CLASSIFICATION SYSTEM) "." CONSISTENCY OF SOILS SUCH AS SOFT, MEDIUM, HARD, LOOSE, DENSE, ETC., ARE RELATIVE TERMS BASED ON ESTIMATED UNDISTURBED SHEAR STRENGTH OF THE MATERIAL AS DETERMINED BY VISUAL CLASSIFICATION POCKET PENETROMETER TESTS AND PENETRATION RESISTANCE DURING SAMPLING.
2. FIGURES TO THE RIGHT OF BORING LOGS ARE WATER CONTENTS IN IN PERCENT OF THE DRY WEIGHT, DRY DENSITY, LIQUID LIMIT, PLASTIC LIMIT AND BAR LINER SHRINKAGE. (MC-UDW,LL-PL) (B.L.S.*). FIGURES TO THE LEFT OF BORING LOGS ARE BLOWS PER FOOT PENETRATION FROM STANDARD PENETRATION TESTING.
3. BORINGS WERE DRILLED USING WET ROTARY DRILLING TECHNIQUES AND UNDISTURBED SAMPLES WHERE RECOVERED WITH A 3-INCH DIAMETER THIN WALL SAMPLER WHERE COHESIVE MATERIALS WERE ENCOUNTERED. WHERE COHESIONLESS MATERIALS WERE ENCOUNTERED, DISTURBED SAMPLES WERE TAKEN WITH A SPLIT SPOON SAMPLER DURING PERFORMANCE OF STANDARD PENETRATION TESTING.
4. WATER TABLE LEVELS SHOWN ON BORING LOGS WERE DETERMINED AFTER DRILLING BORINGS BY MEASURING THE TOP OF FLUID LEVELS IN THE BORINGS.INASMUCH AS WET ROTARY DRILLING TECHNIQUES AND DRILLING MUD WERE USED TO DRILL THE HOLES, THE LEVEL OF DRILLING FLUIDS IN THE BORE HOLES MAY NOT HAVE STABLILIZED TO THE LEVEL OF THE ACTUAL WATER TABLE. ADDITIONALLY, WATER TABLES IN THE FIELD ARE LIKELY TO FLUCTUATE DEPENDING ON WEATHER CONDITIONS. THEREFORE, SOME VARIATION SHOULD BE ANTICIPATED BETWEEN WATER TABLES INDICATED AND WATER TABLES ENCOUNTERED IN THE FIELD.

VISUAL CLASSIFICATIONS:

Btbn Bioturban	Int Interbedded	S Stiff
Bn Brown(ish)	L Loose	Sd Sand(y)
Calc Calcareous	Ly Layer(s)	Si Silty
Cl Clay(ey)	Lt Light	Slks Slicken Sides
D Dense	Mat Material	Sms Seams
Dep Deposit(s)	Med Medium	So Soft
Dk Dark	N.P.	Tn Tan(nish)
F Firm	N.V.	Tr Trace(s)
Fer Ferrous	Nod Nodules	V Very
Fl Fill	Poc Pocket(s)	W With
Gy Gray(ish)	R Red(dish)	W.O.H. Weight Of Hammer
H Hard	Rts Root(s)	W.O.R. Weight Of Rod
		W.T. Water Table

LABORATORY CLASSIFICATION

CH INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS.

CL INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, LEAN CLAYS.

ML INORGANIC SILTS AND VERY FINE SANDS, WITH SLIGHT PLASTICITY.

SM SILTY SANDS, SAND-SILT MIXTURES.

SP POORLY GRADED SANDS OR GRAVELLY SANDS, LITTLE OR NO FINES.
SP-SM SLIGHTLY SILTY SANDS, SANDS WITH SOME SILTS.

US Army Corps of Engineers
Galveston District

Rev. | Description | Date | By

Drawn by: PN & RB | Date: MARCH 2008 | Rev. —
Designed by: RB | Scale: AS SHOWN
Checked by: RB
Submitted by: LORI K. THOMAS, P.E., Chief, Geotech/Structures Section
Approval/Recommended: HARRISON T. SUTCLIFFE, P.E., Chief, Engineering Branch
Approved by: PETE G. PEREZ, P.E., Chief, Engineering and Construction Division

U.S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS

PREPARED UNDER THE DIRECTION OF
DAVID C. WESTON, Col., C.E.,
DISTRICT ENGINEER

NOTE:

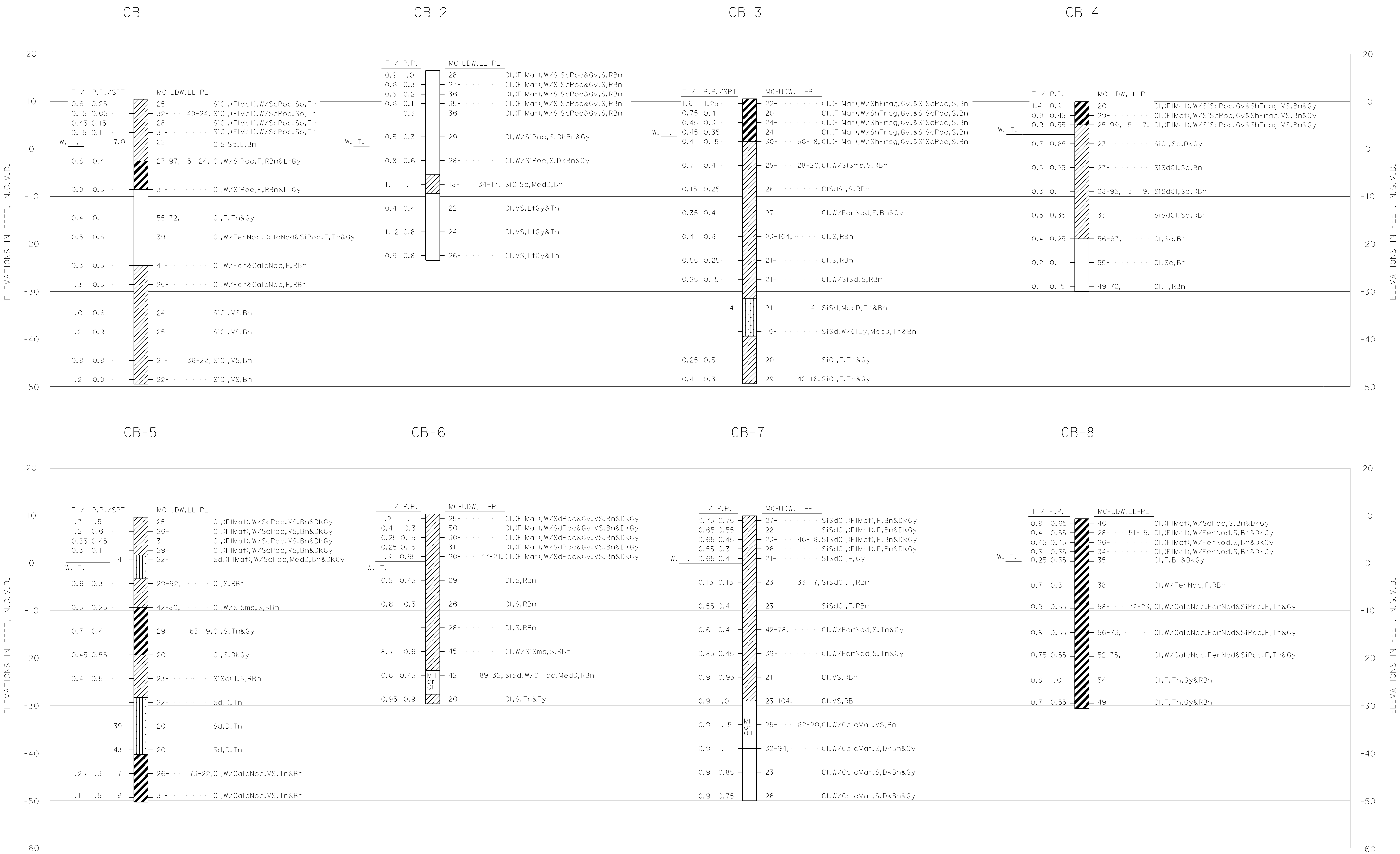
FREEPORT HARBOR NAVIGATION STUDY

PLACEMENT AREA 8 & 9
LOG OF BORINGS

Drawing No.:
F-07

Sheet of X

File No.



NOTE:
SEE DRAWING F-13 FOR BORING NOTES AND LEGEND.

US Army Corps of Engineers
Galveston District

Drawn by: PN & RB
Designed by: RB
Checked by: RB
Submitted by: LORI K. THOMAS, P.E. Chief, Geotech/Structures Section
Date: MARCH 2008
Scale: AS SHOWN
Approval/Recommended: HARRISON T. SUTCLIFFE, P.E. Chief, Engineering Branch
Approved by: PETE G. PEREZ, P.E. Chief, Engineering and Construction Division
Rev.

U.S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS

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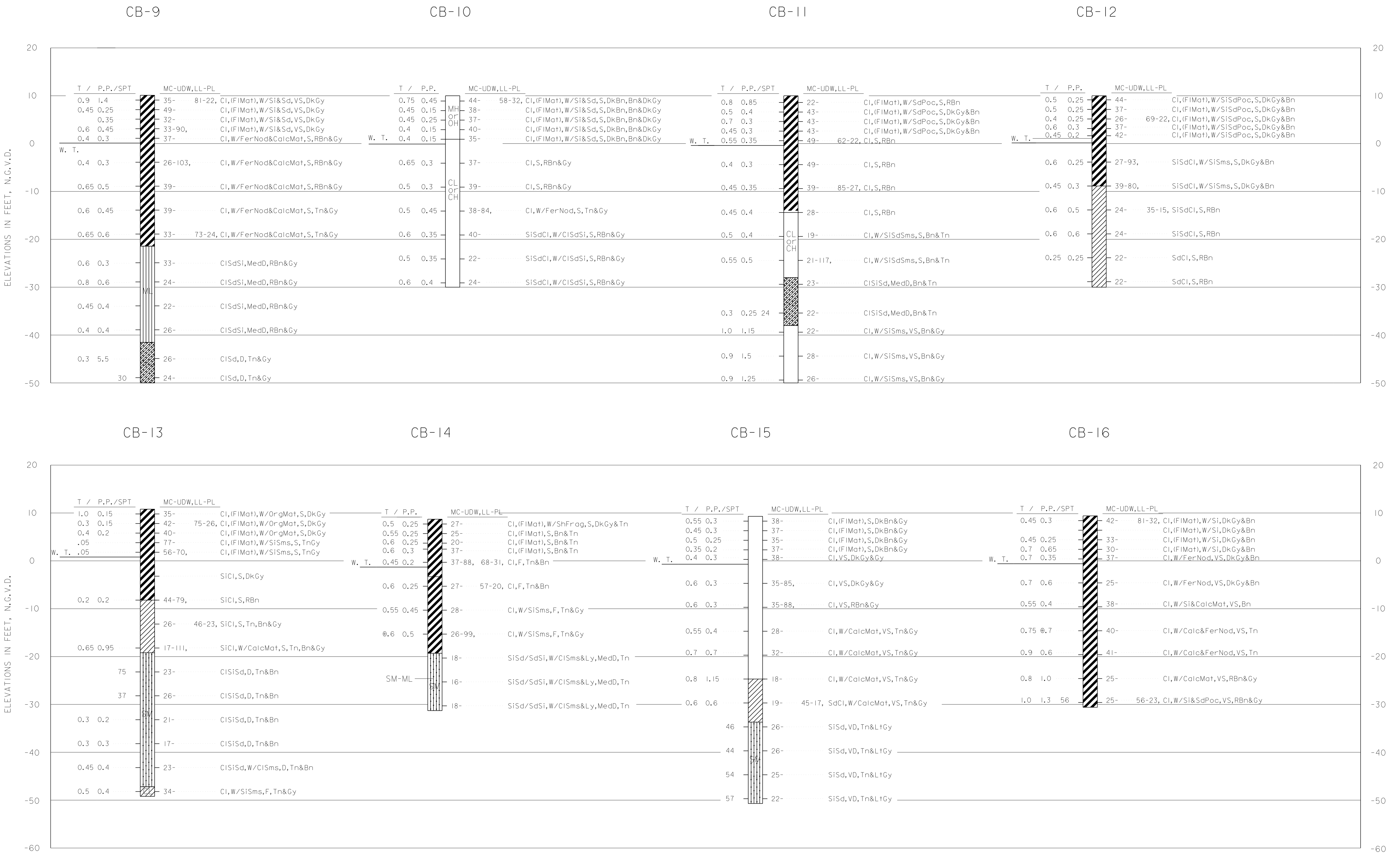
DISTRICT ENGINEER

FREEPORT HARBOR NAVIGATION STUDY

PLACEMENT AREA 1
LOG OF BORINGS

Drawing No.:
F-08
Sheet of X
File No.



NOTE:
SEE DRAWING F-13 FOR BORING NOTES AND LEGEND.

US Army Corps of Engineers
Galveston District

Drawn by: PN & RB	Designed by: RB	Checked by: RB	Date: MARCH 2008	Scale: AS SHOWN	Rev.

Submitted by: LORI A. THOMAS, P.E. Chief Geotech/Structures Section
Approval Recommended: HARRISON T. SUTCLIFFE, P.E. Chief Engineering Branch
Approved by: PETE G. PEREZ, P.E. Chief, Engineering and Construction Division

U.S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS

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DAVID C. WESTON, Col., C.E.,
DISTRICT ENGINEER

FREEPORT HARBOR NAVIGATION STUDY

PLACEMENT AREA 1
LOGS OF BORINGS

Drawing No.: F-09

Sheet of X

File No.

NOTE:
SEE DRAWING F-13 FOR BORING NOTES AND LEGEND.

US Army Corps of Engineers
Galveston District

Date | Description | Rev.

Drawn by: PN & RB
Designed by: RB
Checked by: RB
Date: MARCH 2008
Scale: AS SHOWN
Rev.
Submitted by: LORI K. THOMAS, P.E. Chief, Geotech/Structures Section
Approval/Recommended: HARRISON T. SUTCLIFFE, P.E. Chief, Engineering Branch
Approved by: PETE G. PEREZ, P.E. Chief, Engineering and Construction Division

U.S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS

PREPARED UNDER THE DIRECTION OF
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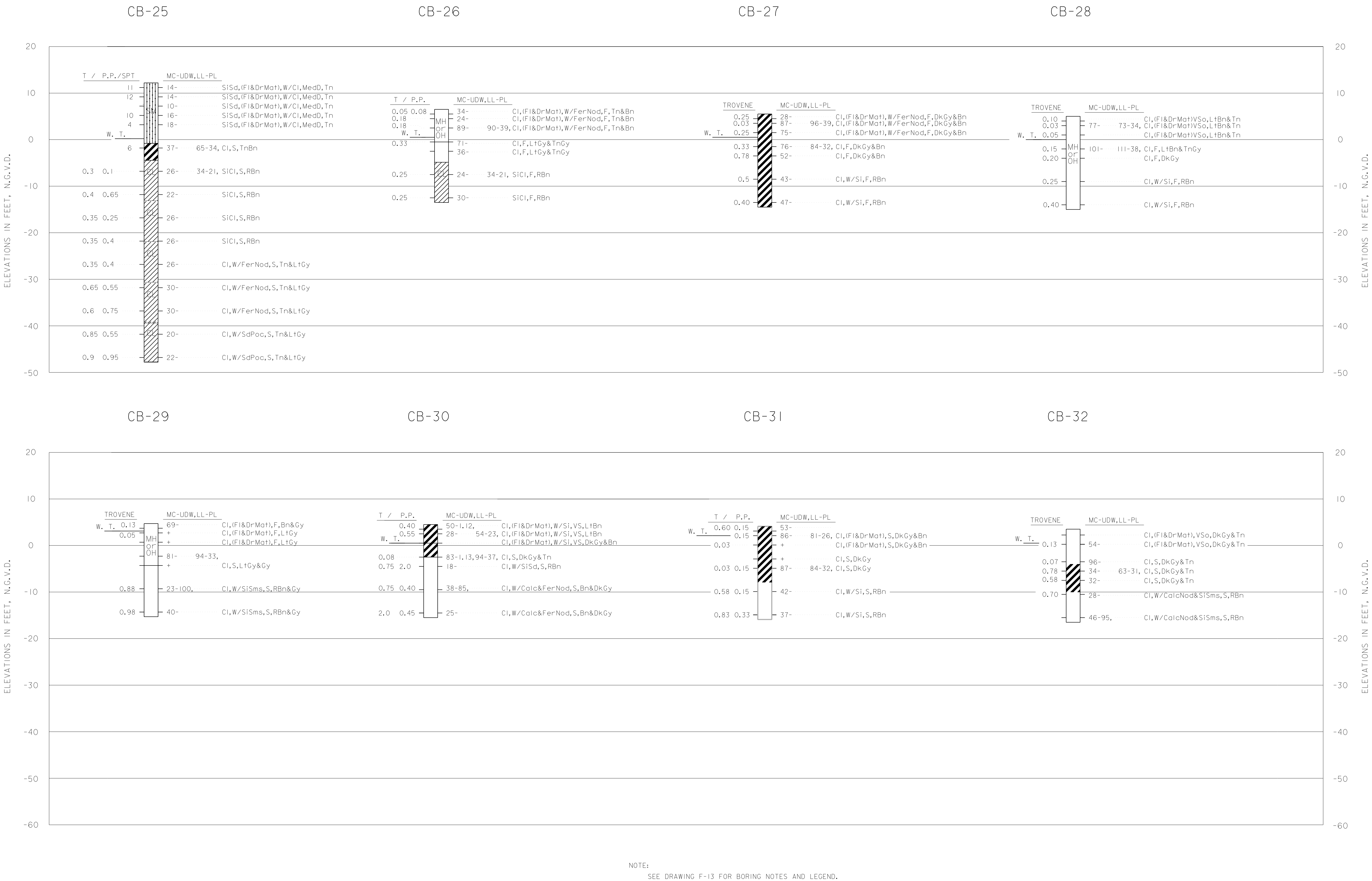
DISTRICT ENGINEER

FREEPORT HARBOR NAVIGATION STUDY

PLACEMENT AREA 1
LOGS OF BORINGS

Drawing No.:
F-10
Sheet of XX
File No.



US Army Corps of Engineers
Galveston District

Date | Description | Rev.

Drawn by: PN & RB
Designed by: RB
Checked by: RB
Date: MARCH 2008
Scale: AS SHOWN
Submitted by: LORI K. THOMAS, P.E. Chief, Geotech/Structures Section
Approval/Recommended: HARRISON T. SUTCLIFFE, P.E. Chief, Engineering Branch
Approved by: PETE G. PEREZ, P.E. Chief, Engineering and Construction Division

U.S. ARMY ENGINEER DISTRICT, GALVESTON
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GALVESTON, TEXAS

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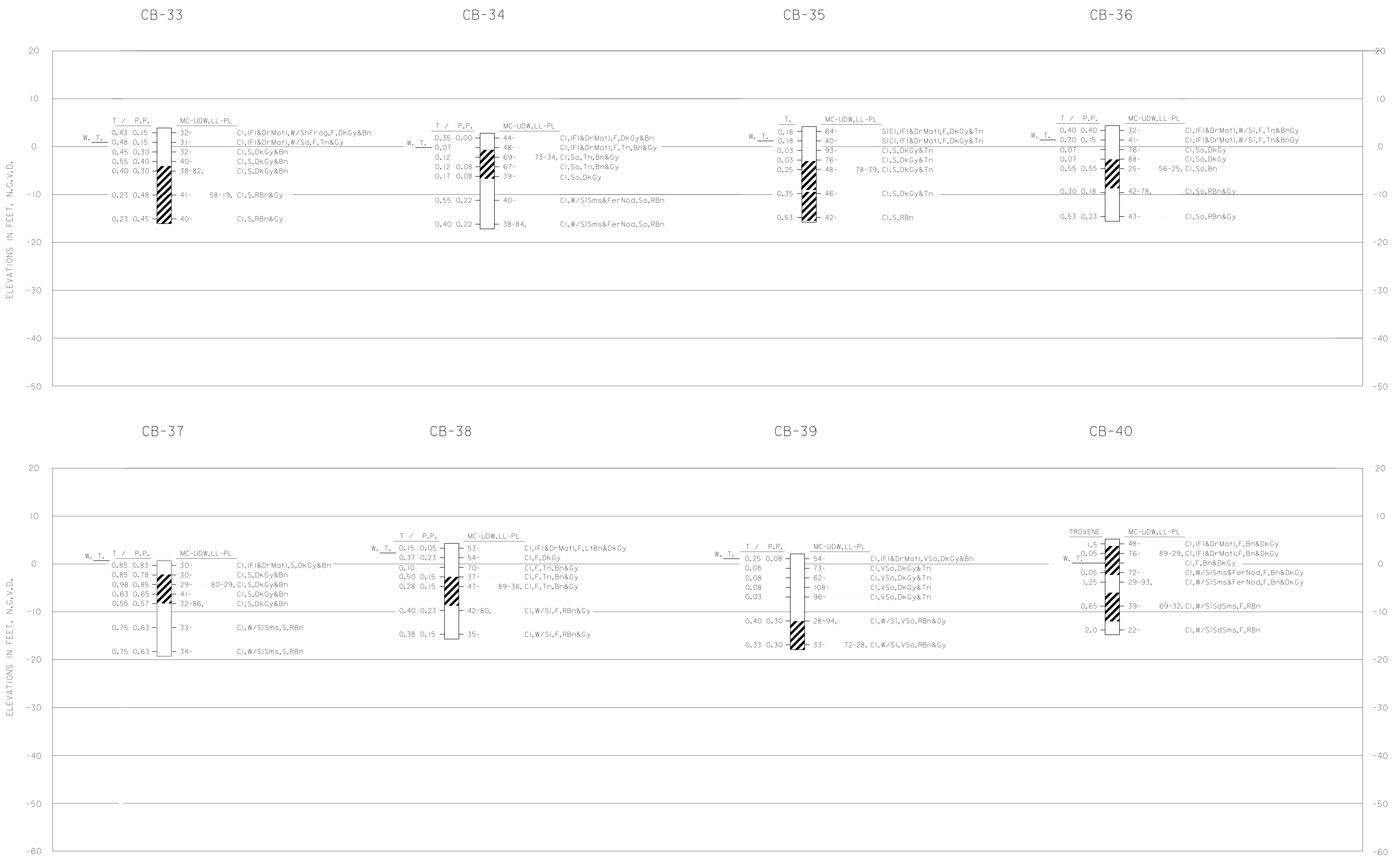
FREEPORT HARBOR NAVIGATION STUDY

PLACEMENT AREA 1
LOGS OF BORINGS

Drawing No.:
F-11
Sheet of X
File No.



NOTE:
SEE DRAWING F-13 FOR BORING NOTES AND LEGEND.

US Army Corps of Engineers
Galveston District

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Approved by: PETE G. PEREZ, P.E., Chief, Engineering and Construction Division
Date: MARCH 2008
Scale: AS SHOWN
Approval Recommended: HARRISON T. SUTCLIFFE, P.E., Chief, Engineering Branch

U.S. ARMY ENGINEER DISTRICT, GALVESTON
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GALVESTON, TEXAS

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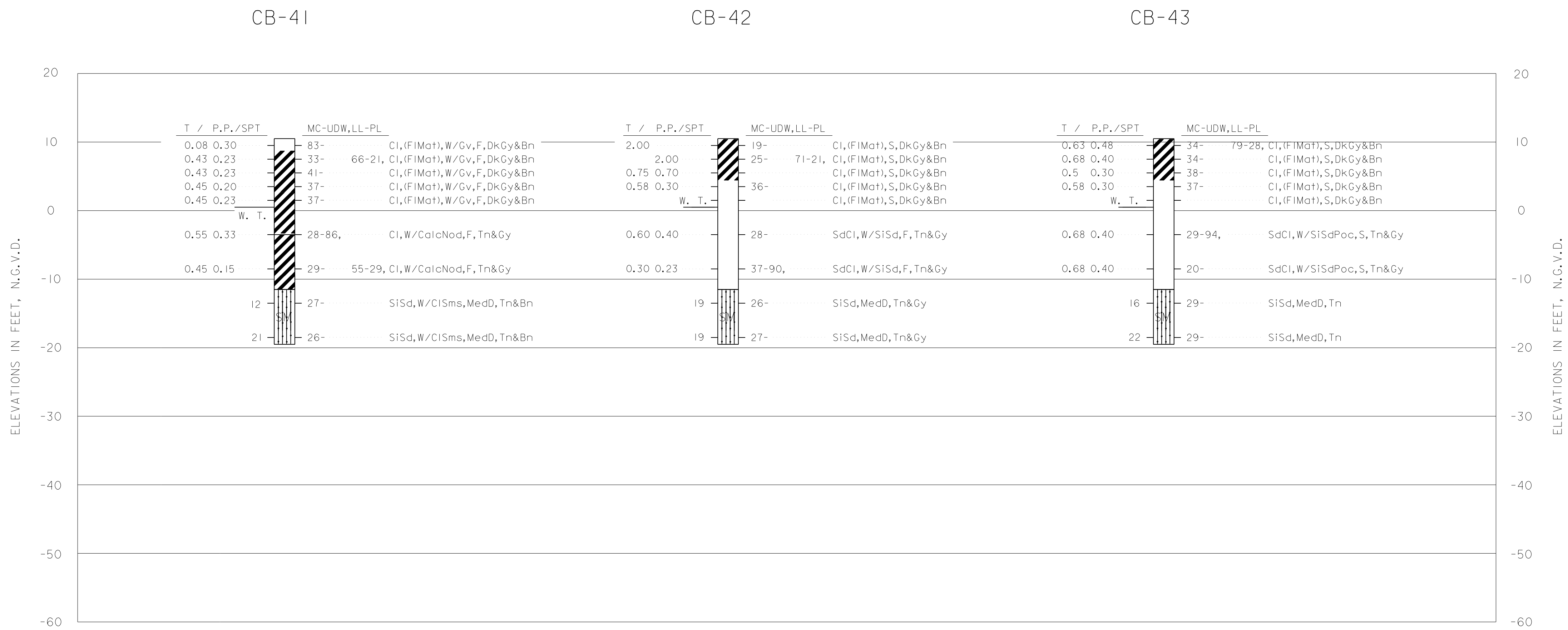
FREEPORT HARBOR NAVIGATION STUDY

PLACEMENT AREA 1
LOGS OF BORINGS

Drawing No.:
F-12

Sheet of X

File No.



NOTES;

1. SOILS HAVE BEEN CLASSIFIED IN ACCORDANCE WITH ASTM 2487 "CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES (UNIFIED SOILS CLASSIFICATION SYSTEM)". CONSISTENCY OF SOILS SUCH AS SOFT, MEDIUM, HARD, LOOSE, DENSE, ETC., ARE RELATIVE TERMS BASED ON ESTIMATED UNDISTURBED SHEAR STRENGTH OF THE MATERIAL AS DETERMINED BY VISUAL CLASSIFICATION POCKET PENETROMETER TESTS AND PENETRATION RESISTANCE DURING SAMPLING.

2. FIGURES TO THE RIGHT OF BORING LOGS ARE WATER CONTENTS IN PERCENT OF THE DRY WEIGHT, DRY DENSITY, LIQUID LIMIT, PLASTIC LIMIT, AND BAR LINEAR SHRINKAGE. (MC-UDW),(LL-PL),(B.L.S.)* FIGURES TO THE LEFT OF BORING LOGS ARE BLOWS PER FOOT OF PENETRATION FROM STANDARD PENETRATION TESTING.

3. BORINGS WERE DRILLED USING WET ROTARY DRILLING TECHNIQUES AND UNDISTURBED SAMPLES WERE RECOVERED WITH A 3-INCH DIAMETER THIN WALL SAMPLER WHERE COHESIVE MATERIALS WERE ENCOUNTERED.WHERE COHESIONLESS MATERIALS WERE ENCOUNTERED, DISTURBED SAMPLES WERE TAKEN WITH A SPLIT SPOON SAMPLER DURING PERFORMANCE OF STANDARD PENETRATION TESTING.

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VISUAL CLASSIFICATIONS:

Bn Brown(ish)	Gv Gravel(ly)	Sd Sand(y)
Calc Calcareous	Gy Gray(ish)	Si Silty
Cl Clay(ey)	Ly Layer(s)	Sms Seams
D Dense	Lt Light	So Soft
Dk Dark	Mat Material	Tn Tan(nish)
Dr Dredge	Med Medium	V Very
F Firm	Nod Nodules	W With
Fer Ferrous	Poc Pocket(s)	W.T. Water Table
Fl Fill	R Red(dish)	
Frag Fragment(s)	S Stiff	

LABORATORY CLASSIFICATIONS:

CH INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS.

CL INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, LEAN CLAYS.

ML INORGANIC SILTS AND VERY FINE SANDS, WITH SLIGHT PLASTICITY.

SC CLAYEY SANDS, SAND-CLAY MIXTURES.

SM SILTY SANDS, SAND-SILT MIXTURES.

MH: INORGANIC SILTS.
OH: ORGANIC CLAY OF MEDIUM TO HIGH PLASTICITY

US Army Corps of Engineers
Galveston District

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GALVESTON, TEXAS

PREPARED UNDER THE DIRECTION OF
DAVID C. WESTON, Col., C.E.,
DISTRICT ENGINEER

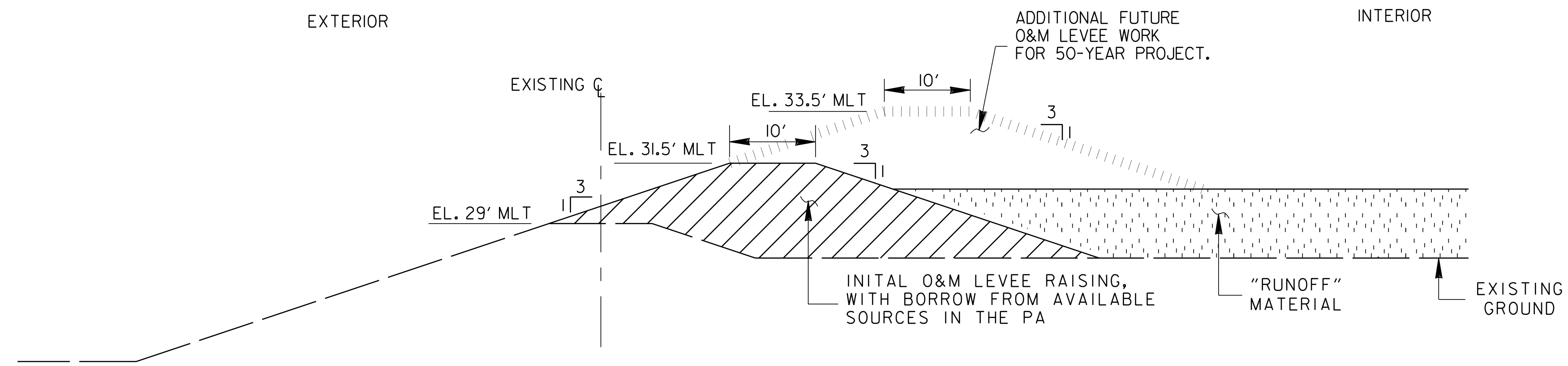
FREEPORT HARBOR NAVIGATION STUDY

PLACEMENT AREA 1
LOGS OF BORINGS

Drawing No.:
F-13

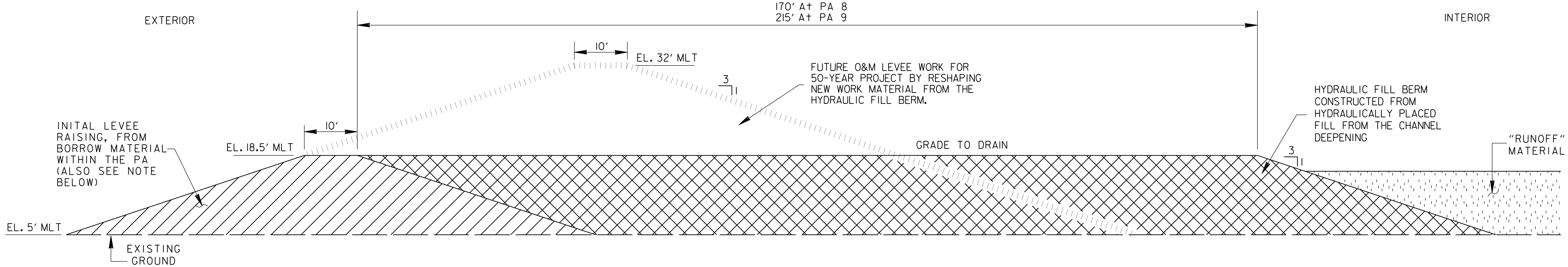
Sheet of X

File No.



TYPICAL LEVEE SECTION - PLACEMENT AREA 1 (LPP)

NOT TO SCALE



TYPICAL LEVEE SECTION - PLACEMENT AREA 8 & 9 (LPP)

NOT TO SCALE

NOTE: ADDITIONAL OUTSIDE TOE BERMS TO BE CONSTRUCTED ADJACENT TO SELECT CRITICAL FOUNDATION LOCATIONS AS DISCUSSED IN THE GEOTECHNICAL SECTION OF THE ENGINEERING APPENDIX.

US Army Corps of Engineers
Galveston District

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GALVESTON, TEXAS

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DISTRICT ENGINEER

FREEPORT HARBOR NAVIGATION STUDY

TYPICAL SECTIONS
LEVEE TEMPLATES AT PA 1, 8, & 9

Drawing No.: F-14

Sheet of X

File No.

Project No. 03.14.859.44 Client: United States Army Corps of Engineers

Project: Freeport Placement Area; Contract No. DACW64-03-D-0008 (FY06); Delivery Order No. 0044

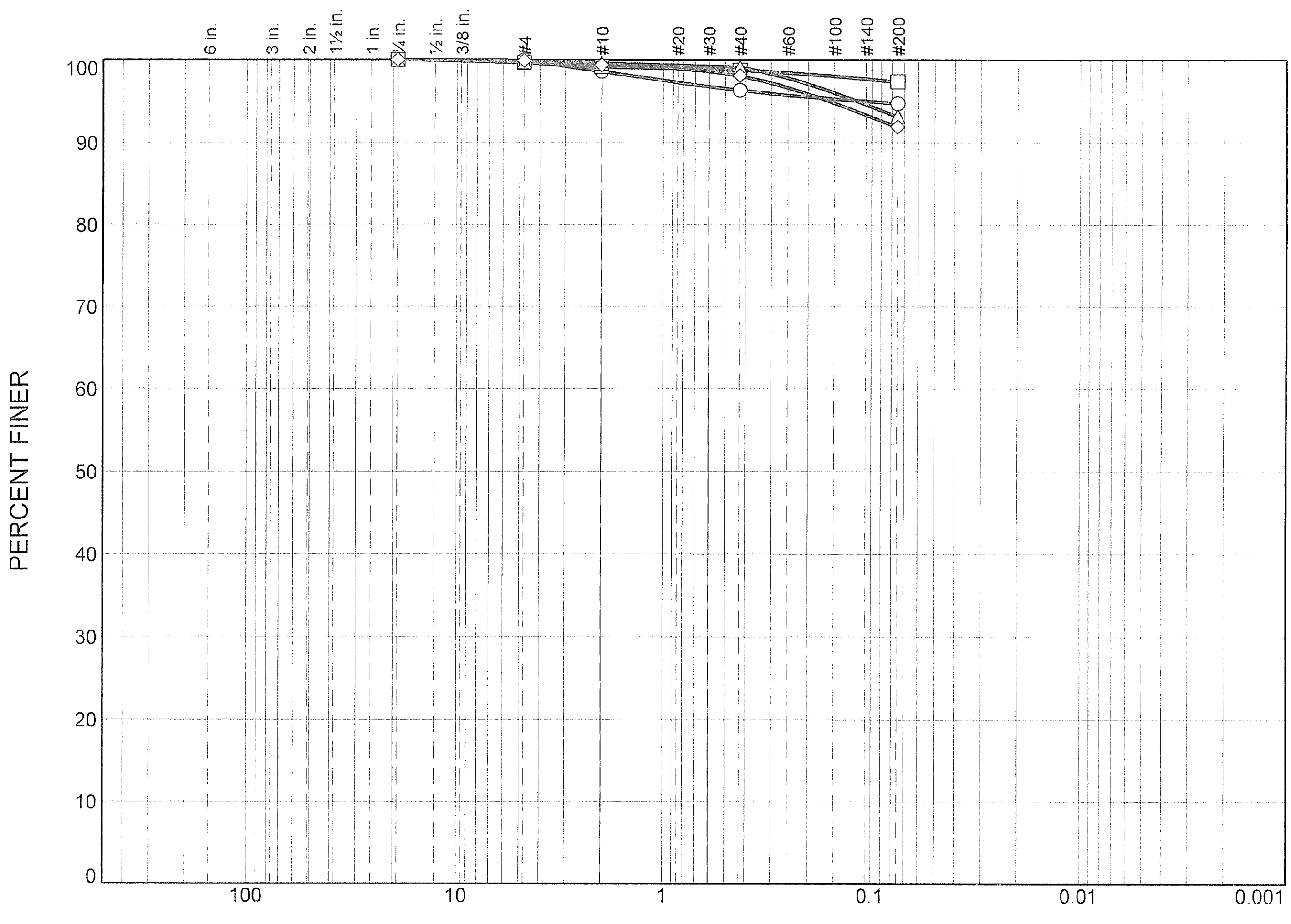
Boring No.	Sample No.	Depth (feet)	Soil Description	USCS	Water Content (%)	Dry Density (pcf)	Liquid Limit	Plastic Limit	Plast. Index	Finer than #200 Sieve (%)	Uc/UU. Compr. (tsf)	Cell Press. (psi)	Failure Strain (%)	Failure Type
06-31														
	3	4-6	Gray and brown FAT CLAY; traces of sand	CH	33.1	88.5	62	23	39	94.8	0.92		10.0	Multiple shear
	4	6-8	Gray and brown SILT; few ferrous nodules, traces of calcareous nodules	ML	30.8		NV	NP	NP	97.4				
	8	17-19	Light gray and brown FAT CLAY; traces of calcareous	CH	26.0	96.4								45 degree
	9	19-21	Light gray and brown FAT CLAY; traces of calcareous	CH	26.0	99.4					0.90		4.4	Multiple shear
	12	25-27	Gray and tan FAT CLAY; few ferrous and calcareous nodules	CH	25.1									
06-32														
	4	6-8	Reddish-brown and gray SILT	ML	24.2	101.0	23	21	2	93.2				
	6	13-15	Gray and tan FAT CLAY; traces of ferrous	CH	38.9	82.4	83	24	59	91.9	0.93		14.5	Bulge
	11	24-26	Gray and tan FAT CLAY; traces of ferrous nodules and few calcareous nodules	CH	25.5									
06-33														
	3	4-6	Brown and dark gray FAT CLAY; traces of ferrous	CH	34.3	86.3	85	25	60	94.8				
	8	14-16	Gray and light gray FAT CLAY; few ferrous nodules, sand pockets and bioturbation	CH	27.1		54	20	34	86.4				
	13	24-26	Gray and tan FAT CLAY; traces of ferrous nodules and bioturbation	CH	21.9									
06-34														
	4	6-8	Brown and gray FAT CLAY; traces of ferrous	CH	39.1	83.2	71	22	49	98.2	0.83		9.0	Multiple shear
	9	16-18	Reddish-brown and light gray LEAN CLAY; traces of ferrous	CL	24.1	102.3	43	19	24	94.5	1.21		4.2	Verticle Shear
	11	20-22	Gray and reddish-brown FAT CLAY; traces of ferrous and calcareous nodules, sand pockets	CH	34.9		89	25	64	96.3				
06-35														
	6	10-12	Brown and gray FAT CLAY	CH	40.4	80.0					0.76		5.5	Slickensided
	7	12-14	Gray and tan LEAN CLAY; traces of sand and ferrous nodules	CL	26.6		34	18	16	90.5				
	13	24-26	Gray and tan FAT CLAY; few calcareous nodules	CH	24.7		63	20	43	90.6				
06-36														
	7	12-14	Gray and tan FAT CLAY; traces of ferrous and calcareous nodules	CH	32.2		74	23	51	92.2				
	9	16-18	Gray and tan LEAN CLAY with SAND; few ferrous noduies	CL	22.2		36	17	19	71.7				
06-37														
	4	6-8	Brown and light gray FAT CLAY	CH	36.6	84.4	73	26	47	96.0	0.75		8.0	Bulge
	5	8-10	Gray and reddish brown FAT CLAY; silt seams, traces of ferrous and calcareous nodules	CH	26.7									
	9	16-18	Gray and tan FAT CLAY; traces of ferrous nodules and calcareous nodules	CH	27.6									
06-38														
	4	6-8	Reddish-brown and gray SANDY LEAN CLAY; silt seams, few ferrous nodules and calcareous nodules	CL	20.8		28	18	10	69.0				
06-39														

Project No. 03.14.859.44 Client: United States Army Corps of Engineers

Project: Freeport Placement Area; Contract No. DACW64-03-D-0008 (FY06); Delivery Order No. 0044

Boring No.	Sample No.	Depth (feet)	Soil Description	USCS	Water Content (%)	Dry Density (pcf)	Liquid Limit	Plastic Limit	Plast. Index	Finer than #200 Sieve (%)	Uc/UU. Compr. (tsf)	Cell Press. (psi)	Failure Strain (%)	Failure Type
	3	4-6	Reddish-brown LEAN CLAY	CL	21.9	103.3	31	22	9	91.7				
06-40														
	4	6-8	Reddish-brown FAT CLAY; sand pockets	CH	26.4	97.8	57	22	35	94.6	0.51		14.5	Bulge
	6	10-12	Gray and tan FAT CLAY; few ferrous nodules, traces of calcareous nodules	CH	30.1		68	24	44	88.5				
	11	20-22	Light gray and brown FAT CLAY; traces of calcareous	CH	23.5	102.0	69	22	47	88.8				45 degree
	12	22-24	Brown and gray FAT CLAY; traces of calcareous	CH	22.1	105.5					2.00		7.0	Multiple shear
06-41														
	3	4-6	Reddish-brown and gray LEAN CLAY; sandy silt seams, traces of ferrous nodules	CL	24.6									
	4	6-8	Gray and brown LEAN CLAY	CL	27.0	98.8	33	21	12	89.1				
	6	10-12	Gray and tan FAT CLAY; sand pockets, traces of ferrous nodules	CH	32.2		72	24	48	85.8				
	8	14-16	Gray and tan FAT CLAY; sand seams and traces of ferrous nodules	CH	34.3									
06-42														
	4	6-8	Brown FAT CLAY	CH	30.1	90.0								
	5	8-10	Reddish-brown and gray LEAN CLAY; silt seams, traces of ferrous nodules	CL	26.1		42	19	23	90.1				
	7	12-14	Gray and tan FAT CLAY; traces of calcareous	CH	39.4	81.0	79	24	55	93.2	0.55		4.8	Slickensided
	9	16-18	Reddish-brown and gray FAT CLAY; traces of ferrous nodules, calcareous nodules and sand	CH	29.6									
	11	20-22	Gray and tan FAT CLAY; few ferrous and calcareous nodules	CH	24.3									
06-43														
	6	10-12	Gray and brown FAT CLAY; sand seams	CH	27.9	94.5	62	22	40	75.1	0.77		11.0	Multiple shear
	9	16-18	Gray and tan FAT CLAY; traces of ferrous and calcareous nodules	CH	24.9		67	21	46	83.1				
		22-24	Gray and tan FAT CLAY; traces of ferrous and calcareous nodules	CH	25.9									

Particle Size Distribution Report (ASTM D 1140)



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	1.4	2.3	1.5	94.8	
□	0.0	0.0	0.4	0.4	0.4	1.4	97.4	
△	0.0	0.0	0.2	0.2	0.5	5.9	93.2	
◇	0.0	0.0	0.1	0.5	1.3	6.2	91.9	

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	06-31	3	4-6	Gray and brown FAT CLAY; traces of sand	CH
□	06-31	4	6-8	Gray and brown SILT; few ferrous nodules, traces of calcareous	ML
				nodules	
△	06-32	4	6-8	Reddish-brown and gray SILT	ML
◇	06-32	6	13-15	Gray and tan FAT CLAY; traces of ferrous	CH

Tolunay-Wong Engineers, Inc.
Houston, Texas

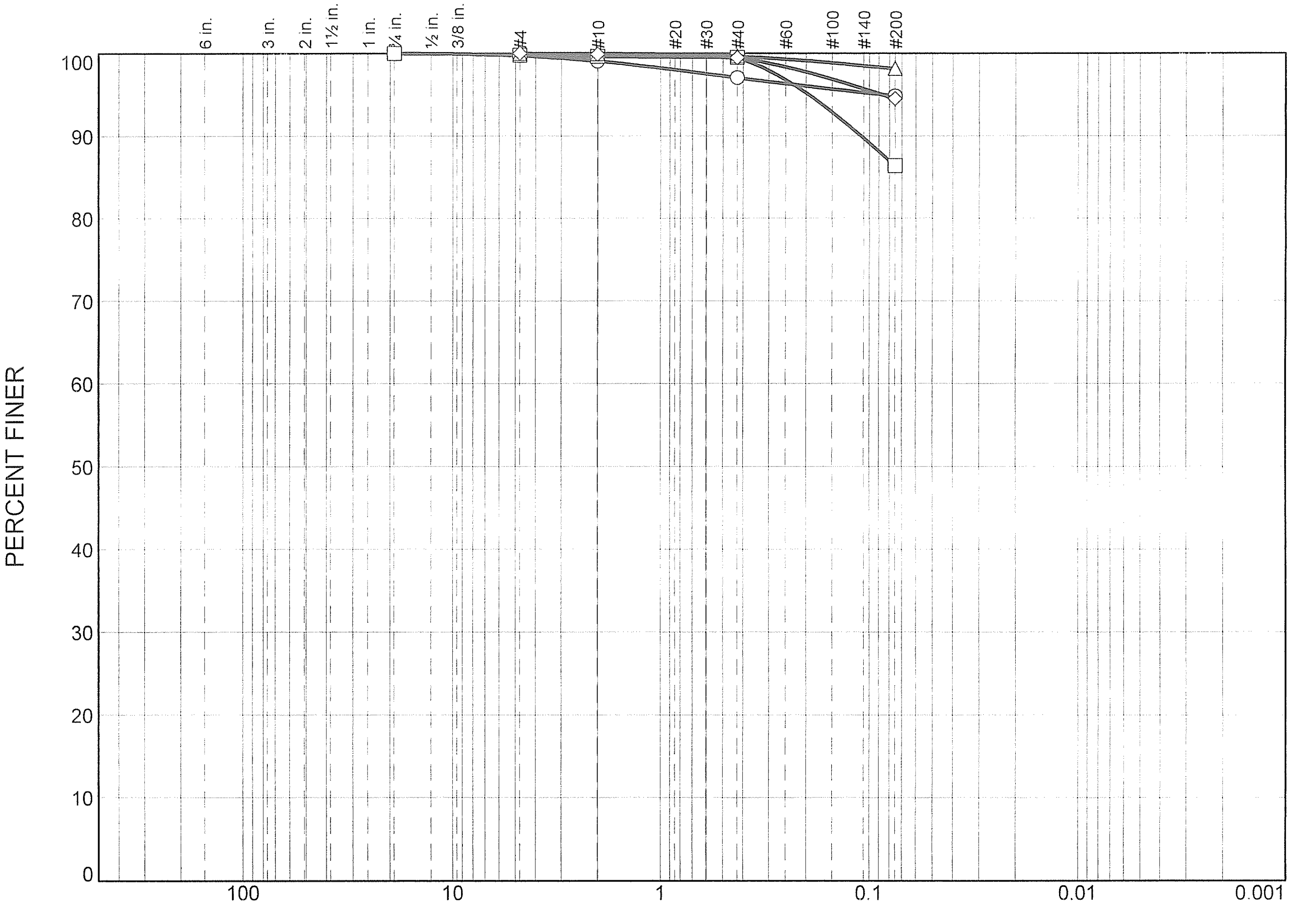
Client: United States Army Corps of Engineers

Project: Freeport Placement Area; Contract No. DACW64-03-D-0008 (FY06); Delivery Order No. 0044

Project No.: 03.14.859.44

Figure B-1

Particle Size Distribution Report (ASTM D 1140)



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.3	0.6	2.0	2.3	94.8	
□	0.0	0.0	0.2	0.1	0.2	13.1	86.4	
△	0.0	0.0	0.0	0.0	0.3	1.5	98.2	
◇	0.0	0.0	0.0	0.1	0.4	5.0	94.5	

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	06-33	3	4-6	Brown and dark gray FAT CLAY; traces of ferrous	CH
□	06-33	8	14-16	Gray and light gray FAT CLAY; few ferrous nodules, sand	CH
				pockets and bioturbation	
△	06-34	4	6-8	Brown and gray FAT CLAY; traces of ferrous	CH
◇	06-34	9	16-18	Reddish-brown and light gray LEAN CLAY; traces of ferrous	CL

Tolunay-Wong Engineers, Inc. Houston, Texas

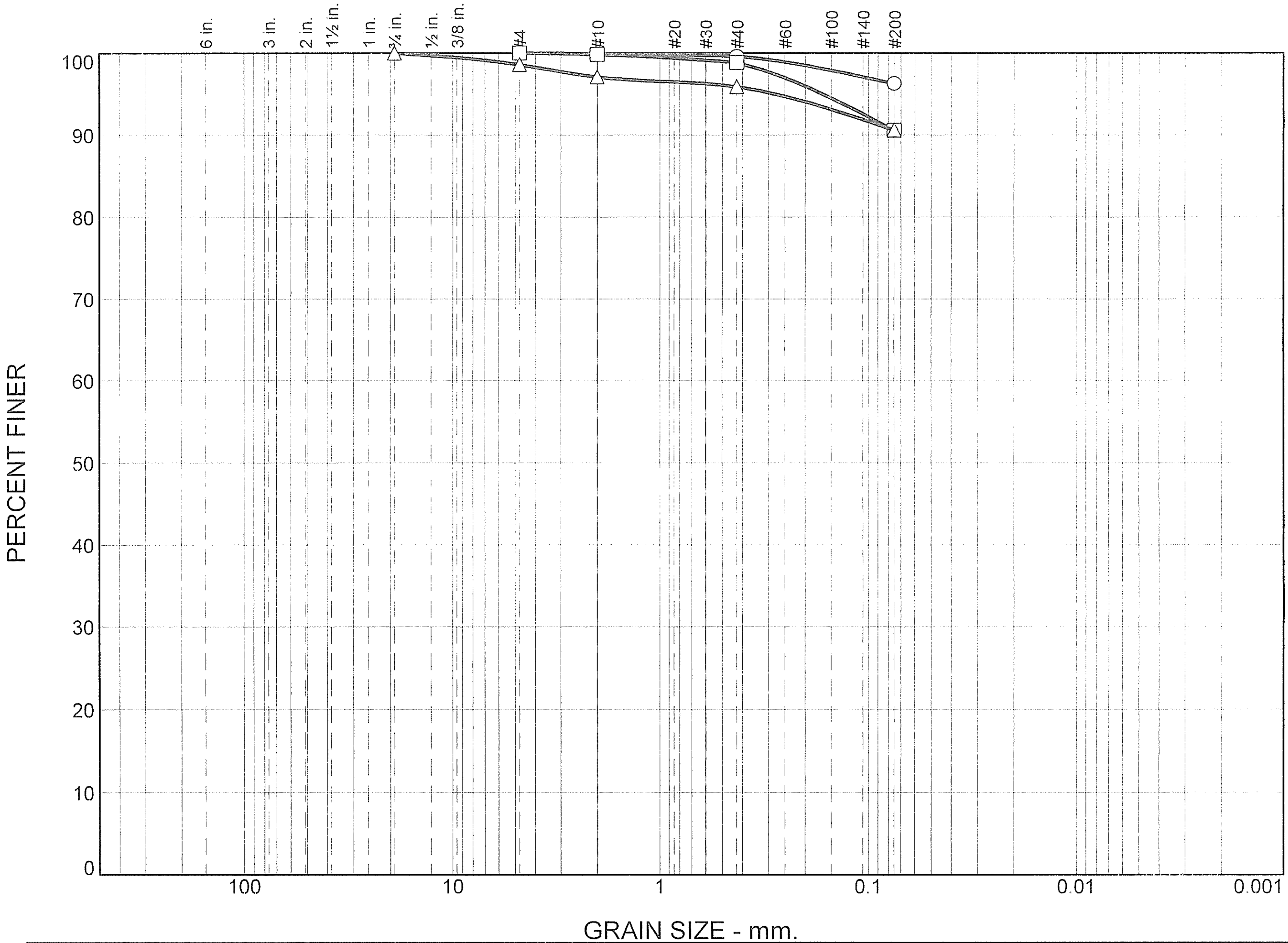
Client: United States Army Corps of Engineers

Project: Freeport Placement Area; Contract No. DACW64-03-D-0008 (FY06); Delivery Order No. 0044

Project No.: 03.14.859.44

Figure B-2

Particle Size Distribution Report (ASTM D 1140)



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.1	0.3	3.3	96.3	
□	0.0	0.0	0.0	0.2	1.0	8.3	90.5	
△	0.0	0.0	1.4	1.5	1.2	5.3	90.6	

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	06-34	11	20-22	Gray and reddish-brown FAT CLAY; traces of ferrous and	CH
				calcareous nodules, sand pockets	
□	06-35	7	12-14	Gray and tan LEAN CLAY; traces of sand and ferrous nodules	CL
△	06-35	13	24-26	Gray and tan FAT CLAY; few calcareous nodules	CH

Tolunay-Wong Engineers, Inc. Houston, Texas

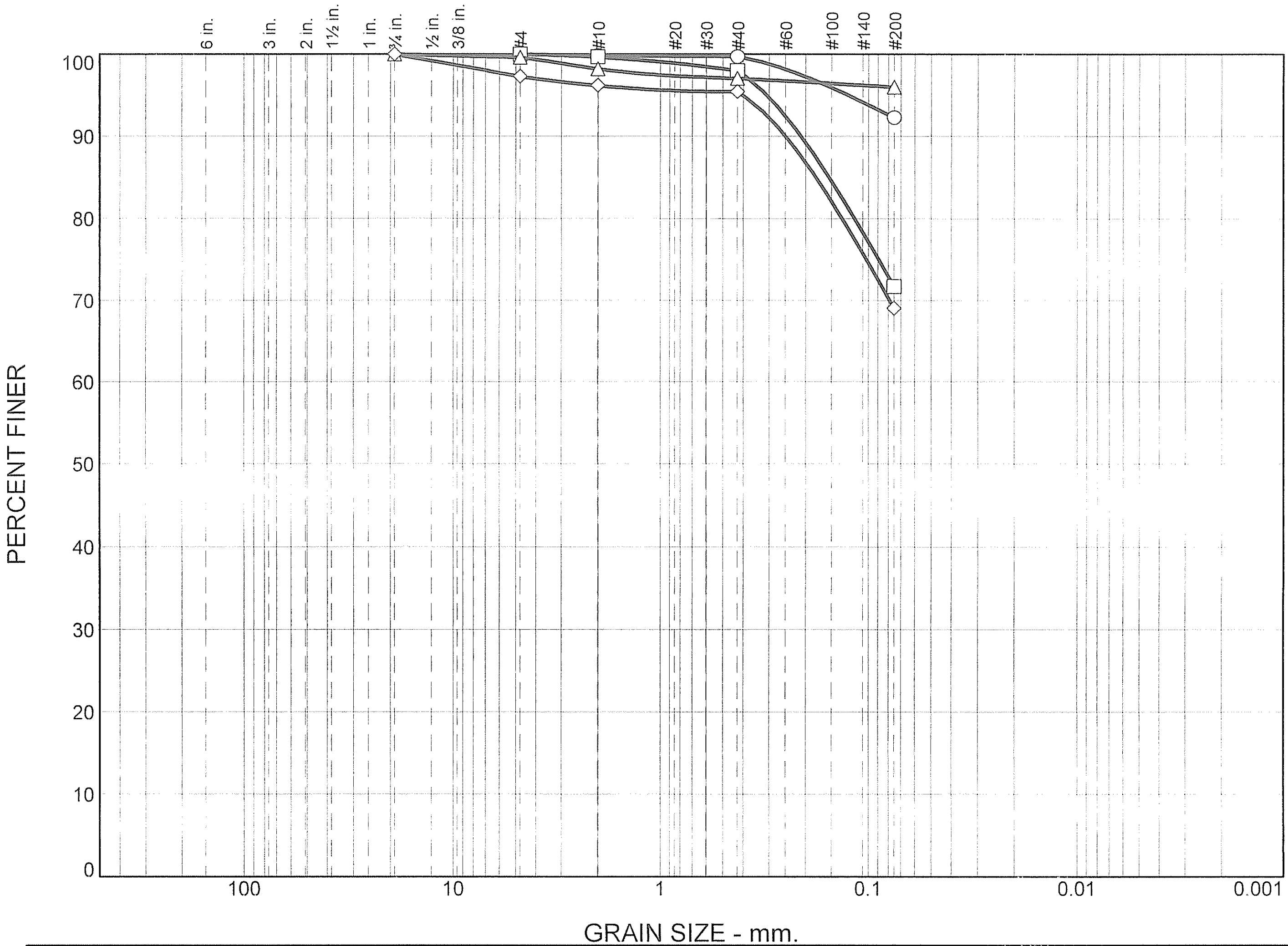
Client: United States Army Corps of Engineers

Project: Freeport Placement Area; Contract No. DACW64-03-D-0008 (FY06); Delivery Order No. 0044

Project No.: 03.14.859.44

Figure B-3

Particle Size Distribution Report (ASTM D 1140)



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.1	0.2	7.5	92.2	
□	0.0	0.0	0.0	0.3	1.7	26.3	71.7	
△	0.0	0.0	0.4	1.4	1.2	1.0	96.0	
◇	0.0	0.0	2.7	1.1	0.8	26.4	69.0	

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	06-36	7	12-14	Gray and tan FAT CLAY; traces of ferrous and calcareous	CH
				nodules	
□	06-36	9	16-18	Gray and tan LEAN CLAY with SAND; few ferrous nodules	CL
△	06-37	4	6-8	Brown and light gray FAT CLAY	CH
◇	06-38	4	6-8	Reddish-brown and gray SANDY LEAN CLAY; silt seams, few	CL

Tolunay-Wong Engineers, Inc. Houston, Texas

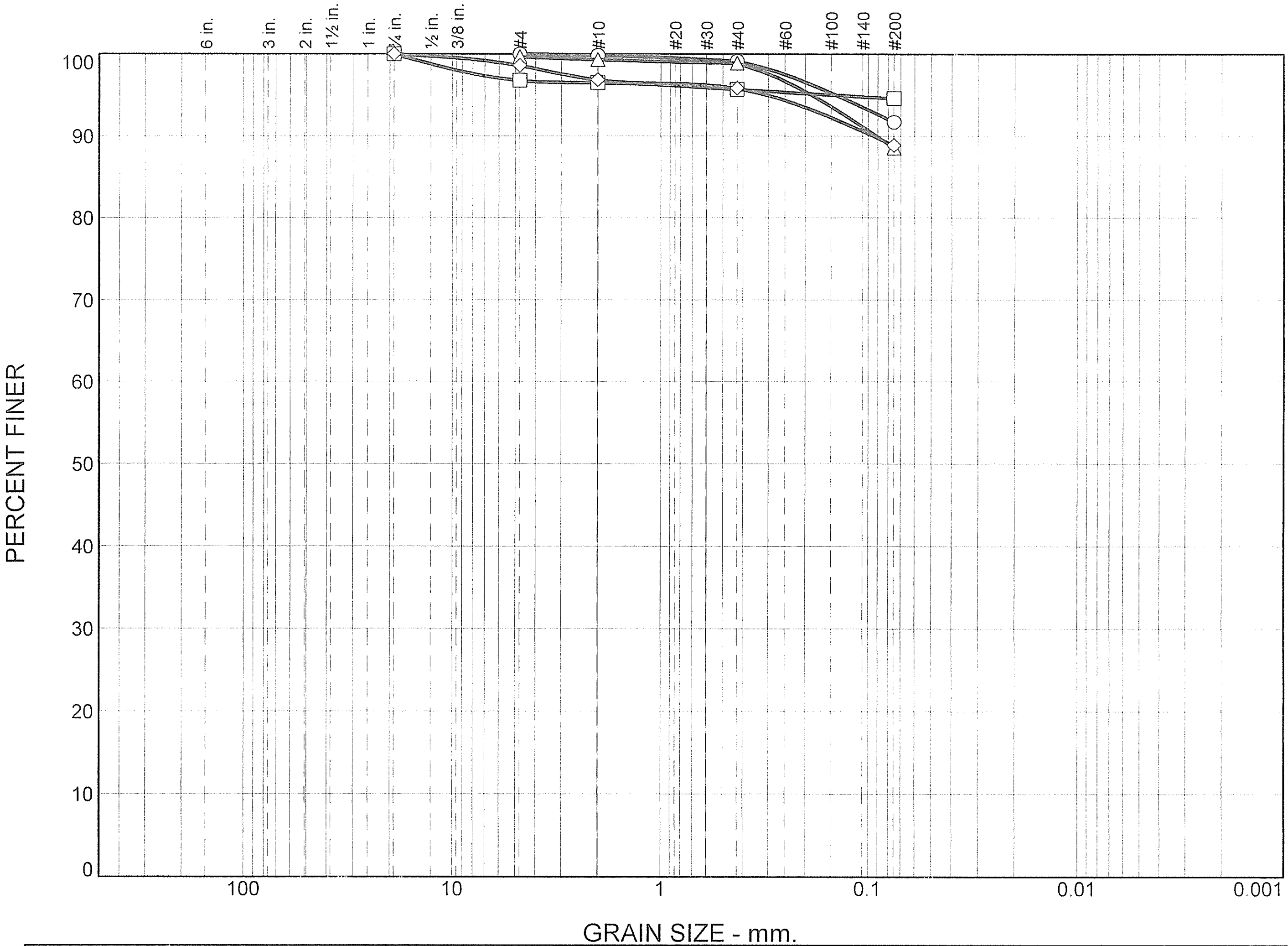
Client: United States Army Corps of Engineers

Project: Freeport Placement Area; Contract No. DACW64-03-D-0008 (FY06); Delivery Order No. 0044

Project No.: 03.14.859.44

Figure B-4

Particle Size Distribution Report (ASTM D 1140)



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.1	0.7	7.5	91.7	
□	0.0	0.0	3.2	0.3	0.8	1.1	94.6	
△				0.4	0.4	10.4	88.5	
◇	0.0	0.0	1.4	1.8	1.0	7.0	88.8	

SOIL DATA

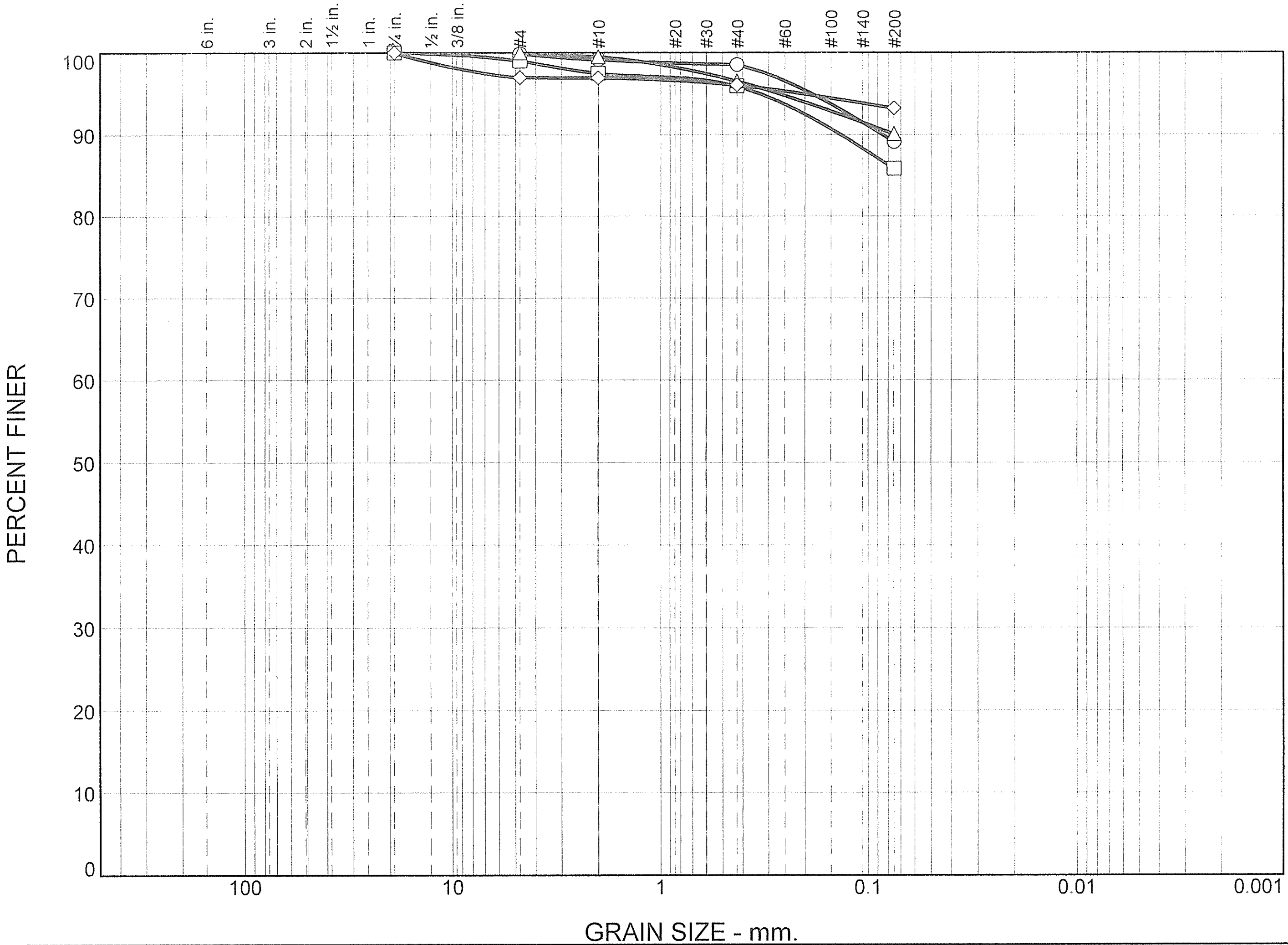
SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	06-39	3	4-6	Reddish-brown LEAN CLAY	CL
□	06-40	4	6-8	Reddish-brown FAT CLAY; sand pockets	CH
△	06-40	6	10-12	Gray and tan FAT CLAY; few ferrous nodules, traces of	CH
				calcareous nodules	
◇	06-40	11	20-22	Light gray and brown FAT CLAY; traces of calcareous	CH

Tolunay-Wong Engineers, Inc.
Houston, Texas

Client: United States Army Corps of Engineers
Project: Freeport Placement Area; Contract No. DACW64-03-D-0008 (FY06); Delivery Order No. 0044
Project No.: 03.14.859.44

Figure B-5

Particle Size Distribution Report (ASTM D 1140)



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○				0.7	0.6	9.5	89.1	
□	0.0	0.0	1.0	1.5	1.6	10.1	85.8	
△	0.0	0.0	0.0	0.5	3.0	6.4	90.1	
◇	0.0	0.0	3.0	0.1	0.9	2.8	93.2	

SOIL DATA

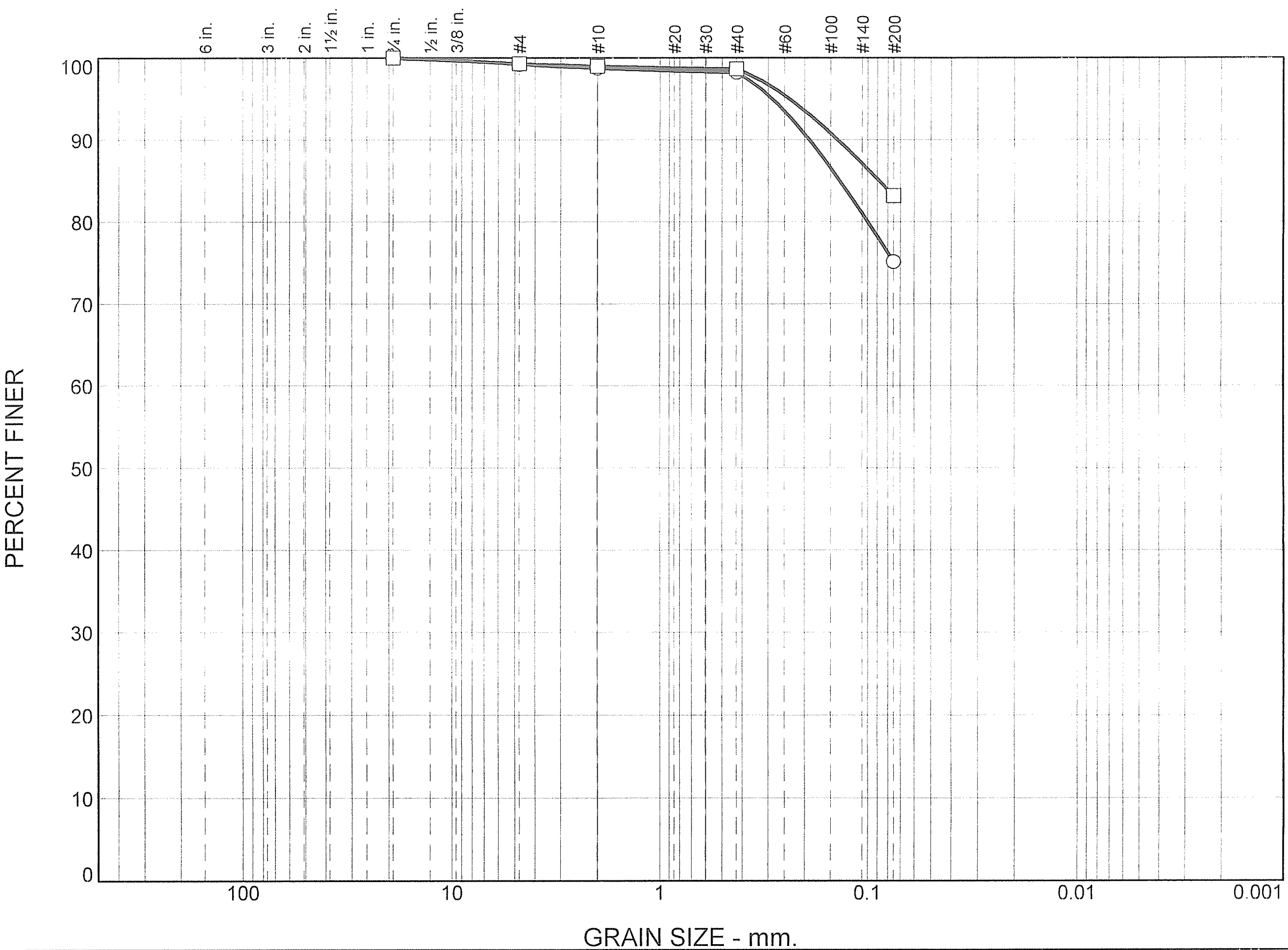
SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	06-41	4	6-8	Gray and brown LEAN CLAY	CL
□	06-41	6	10-12	Gray and tan FAT CLAY; sand pockets, traces of ferrous nodules	CH
△	06-42	5	8-10	Reddish-brown and gray LEAN CLAY; silt seams, traces of	CL
				ferrous nodules	
◇	06-42	7	12-14	Gray and tan FAT CLAY; traces of calcareous	CH

Tolunay-Wong Engineers, Inc.
Houston, Texas

Client: United States Army Corps of Engineers
Project: Freeport Placement Area; Contract No. DACW64-03-D-0008 (FY06); Delivery Order No. 0044
Project No.: 03.14.859.44

Figure B-6

Particle Size Distribution Report (ASTM D 1140)



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.8	0.4	0.6	23.1	75.1	
□	0.0	0.0	0.7	0.3	0.3	15.6	83.1	

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	06-43	6	10-12	Gray and brown FAT CLAY; sand seams	CH
□	06-43	9	16-18	Gray and tan FAT CLAY; traces of ferrous and calcareous nodules	CH

Tolunay-Wong Engineers, Inc.
Houston, Texas

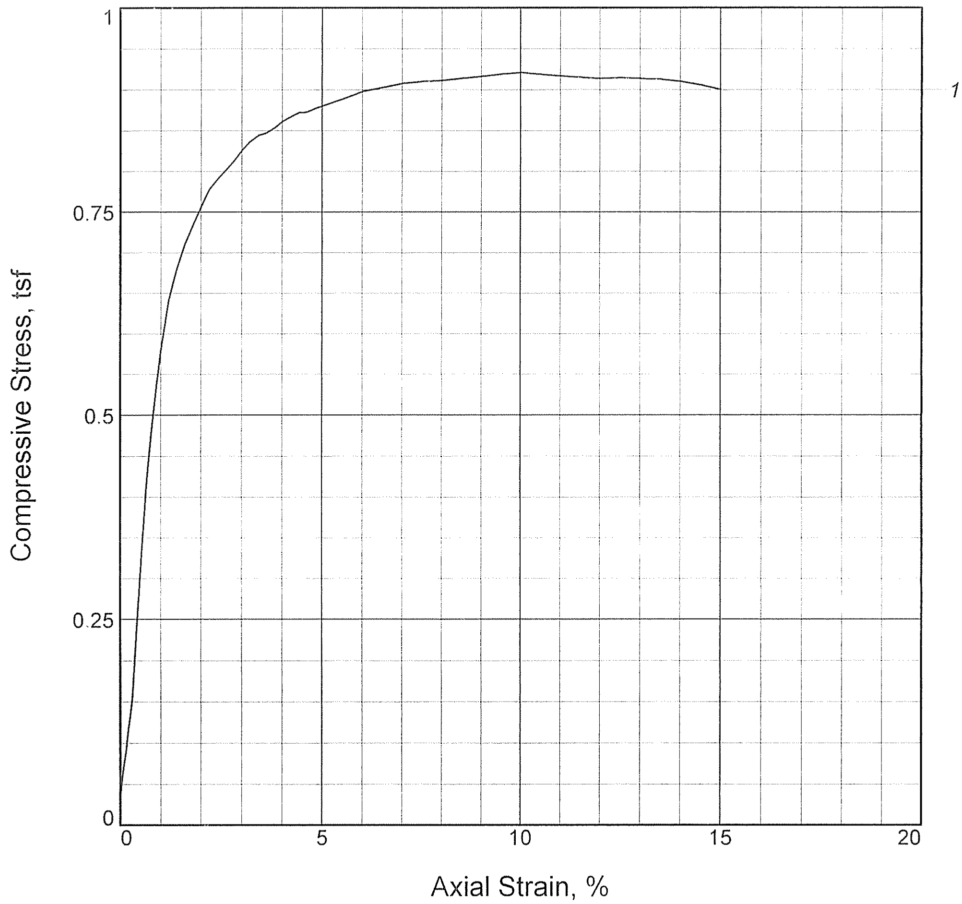
Client: United States Army Corps of Engineers

Project: Freeport Placement Area; Contract No. DACW64-03-D-0008 (FY06); Delivery Order No. 0044

Project No.: 03.14.859.44

Figure B-7

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	0.921			
Undrained shear strength, tsf	0.460			
Failure strain,	10.0			
Strain rate, %/min.	1.00			
Water content, %	33.1			
Wet density, pcf	117.8			
Dry density, pcf	88.5			
Saturation, %	96.8			
Void ratio	0.9396			
Specimen diameter, in.	2.83			
Specimen height, in.	5.92			
Height/diameter ratio	2.09			

Description: Gray and brown FAT CLAY; traces of sand

LL = 62	**PL =** 23	**PI =** 39	**Assumed GS=** 2.75	**Type:** Undisturbed

Project No.: 03.14.859.44

Date: 12/21/05

Remarks:

Test Method: ASTM D 2166

Pocket pen; tsf: 1.75

Failure type: Multiple shear

Figure C-1

Client: United States Army Corps of Engineers

Project: Freeport Placement Area; Contract No. DACW64-03-D-0008 (FY06); Delivery Order No. 0044

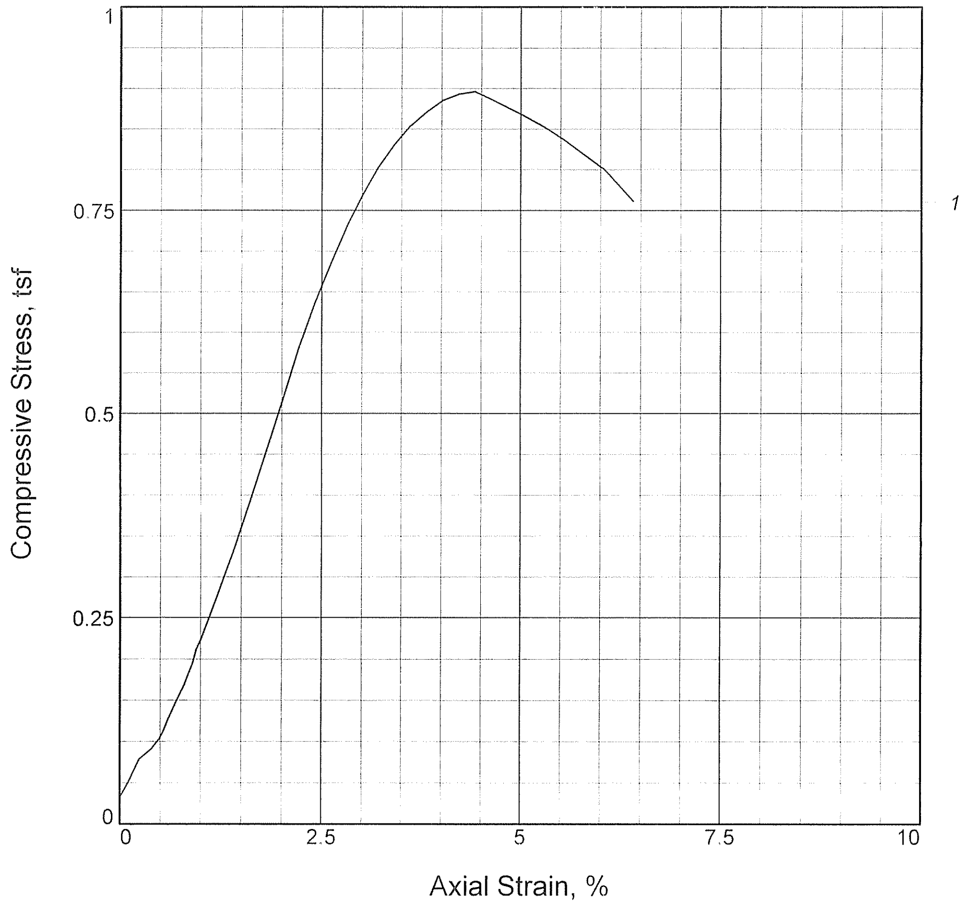
Source of Sample: 06-31 **Depth:** 4-6

Sample Number: 3

UNCONFINED COMPRESSION TEST

Tolunay-Wong Engineers, Inc.

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	0.896			
Undrained shear strength, tsf	0.448			
Failure strain,	4.4			
Strain rate, %/min.	1.00			
Water content, %	26.0			
Wet density, pcf	125.3			
Dry density, pcf	99.4			
Saturation, %	98.3			
Void ratio	0.7265			
Specimen diameter, in.	2.85			
Specimen height, in.	4.36			
Height/diameter ratio	1.53			

Description: Light gray and brown FAT CLAY; traces of calcareous

LL =	PL =	PI =	Assumed GS= 2.75	Type: Undisturbed

Project No.: 03.14.859.44

Date: 12/21/05

Remarks:

Test Method: ASTM D 2166

Pocket pen; tsf: 2.00

Failure type: Multiple shear

Figure C-2

Client: United States Army Corps of Engineers

Project: Freeport Placement Area; Contract No. DACW64-03-D-0008 (FY06); Delivery Order No. 0044

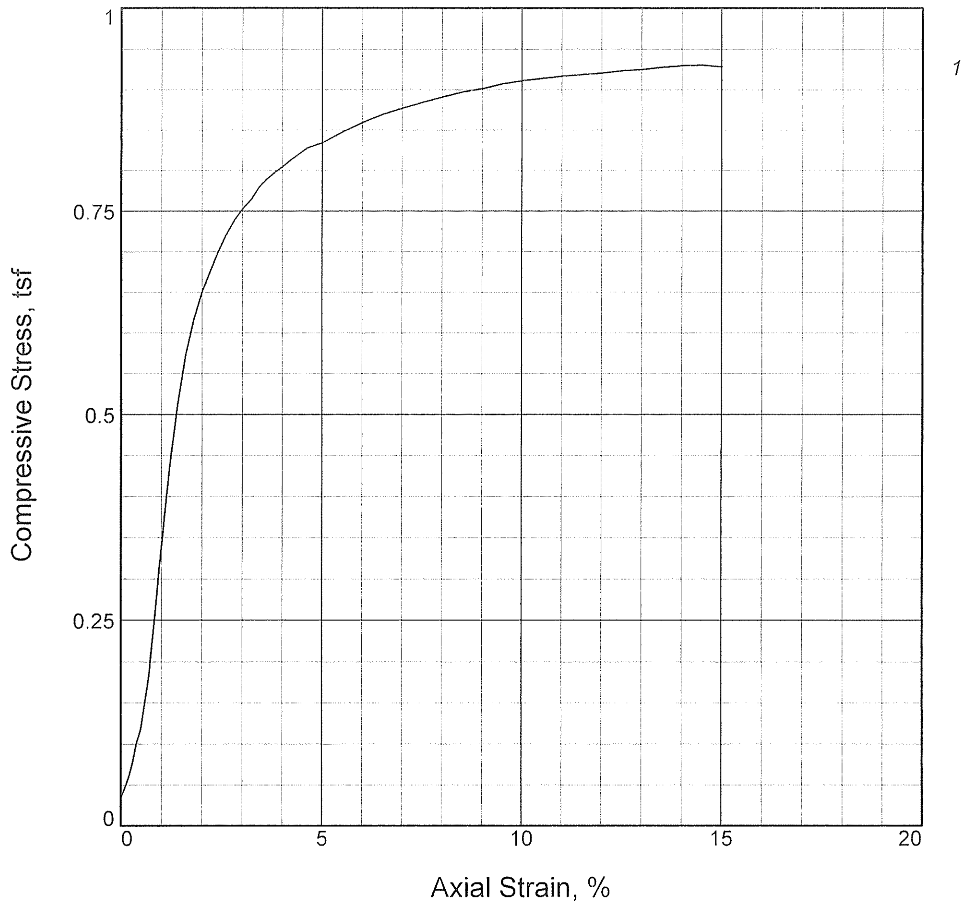
Source of Sample: 06-31 **Depth:** 19-21

Sample Number: 9

UNCONFINED COMPRESSION TEST

Tolunay-Wong Engineers, Inc.

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	0.930			
Undrained shear strength, tsf	0.465			
Failure strain,	14.5			
Strain rate, %/min.	1.00			
Water content, %	38.9			
Wet density, pcf	114.4			
Dry density, pcf	82.4			
Saturation, %	98.6			
Void ratio	1.0836			
Specimen diameter, in.	2.83			
Specimen height, in.	5.91			
Height/diameter ratio	2.09			

Description: Gray and tan FAT CLAY; traces of ferrous

LL = 83	**PL =** 24	**PI =** 59	**Assumed GS=** 2.75	**Type:** Undisturbed

Project No.: 03.14.859.44

Date: 12/21/05

Remarks:

Test Method: ASTM D 2166

Pocket pen; tsf: 1.25

Failure type: Bulge

Figure C-3

Client: United States Army Corps of Engineers

Project: Freeport Placement Area; Contract No. DACW64-03-D-0008 (FY06); Delivery Order No. 0044

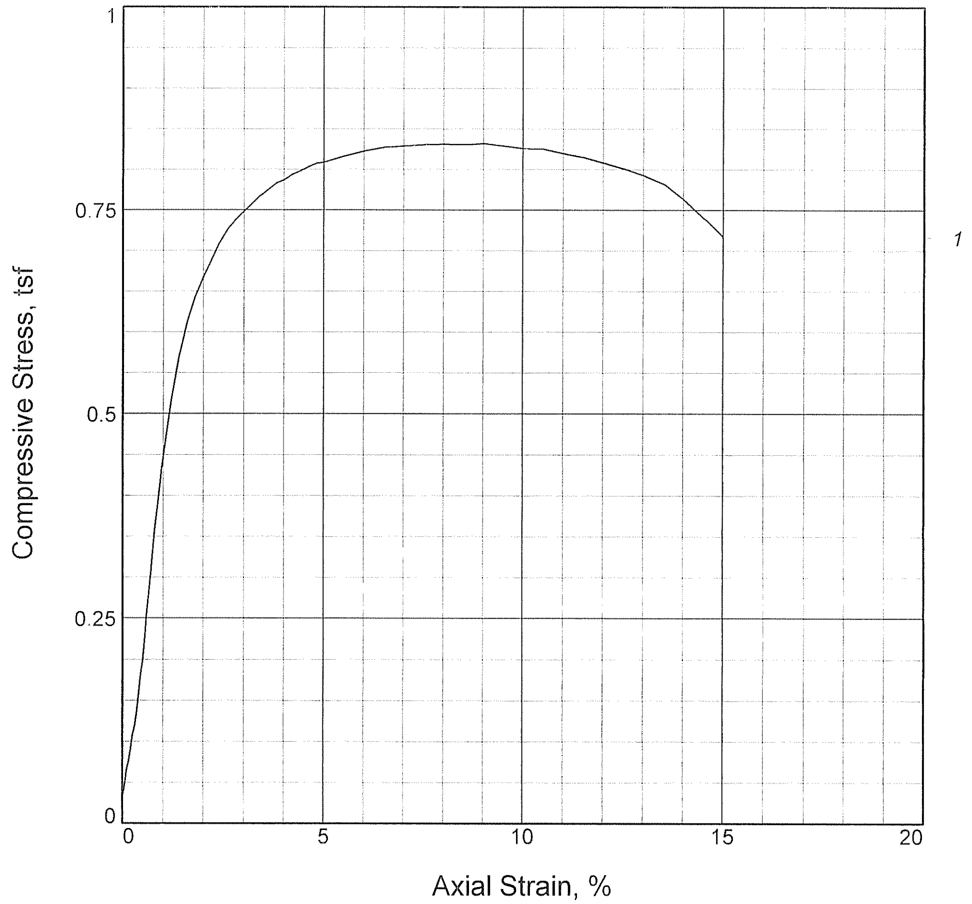
Source of Sample: 06-32 **Depth:** 13-15

Sample Number: 6

UNCONFINED COMPRESSION TEST

Tolunay-Wong Engineers, Inc.

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	0.832			
Undrained shear strength, tsf	0.416			
Failure strain,	9.0			
Strain rate, %/min.	1.00			
Water content, %	39.1			
Wet density, pcf	115.7			
Dry density, pcf	83.2			
Saturation, %	101.1			
Void ratio	1.0638			
Specimen diameter, in.	2.83			
Specimen height, in.	5.91			
Height/diameter ratio	2.09			

Description: Brown and gray FAT CLAY; traces of ferrous

LL = 71	**PL =** 22	**PI =** 49	**Assumed GS=** 2.75	**Type:** Undisturbed

Project No.: 03.14.859.44

Date: 12/21/05

Remarks:

Test Method: ASTM D 2166

Pocket pen; tsf: 1.00

Failure type: Multiple shear

Figure C-4

Client: United States Army Corps of Engineers

Project: Freeport Placement Area; Contract No. DACW64-03-D-0008 (FY06); Delivery Order No. 0044

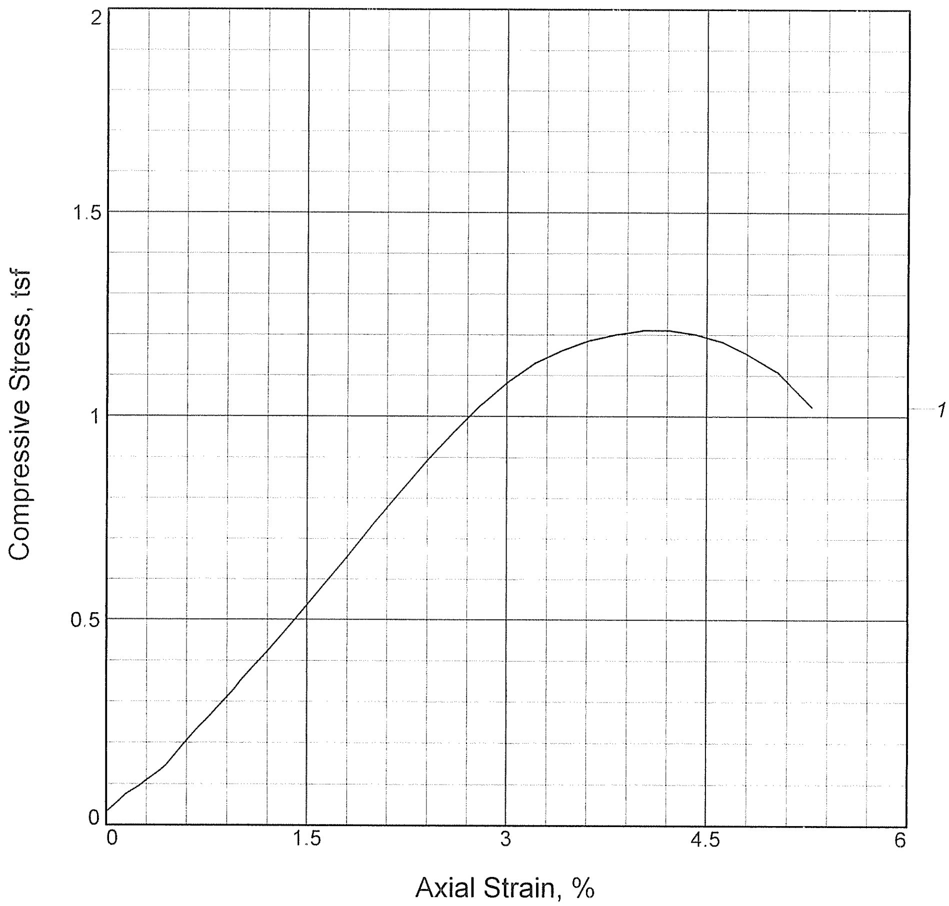
Source of Sample: 06-34 **Depth:** 6-8

Sample Number: 4

UNCONFINED COMPRESSION TEST

Tolunay-Wong Engineers, Inc.

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	1.211			
Undrained shear strength, tsf	0.606			
Failure strain,	4.2			
Strain rate, %/min.	1.00			
Water content, %	24.1			
Wet density, pcf	126.9			
Dry density, pcf	102.3			
Saturation, %	97.6			
Void ratio	0.6782			
Specimen diameter, in.	2.83			
Specimen height, in.	5.90			
Height/diameter ratio	2.08			

Description: Reddish-brown and light gray LEAN CLAY; traces of ferrous

LL = 43	PL = 19	PI = 24	Assumed GS= 2.75	Type: Undisturbed

Project No.: 03.14.859.44

Date: 12/21/05

Remarks:

Test Method: ASTM D 2166

Pocket pen; tsf: 1.00

Failure type: Vertical shear

Figure C-5

Client: United States Army Corps of Engineers

Project: Freeport Placement Area; Contract No. DACW64-03-D-0008 (FY06); Delivery Order No. 0044

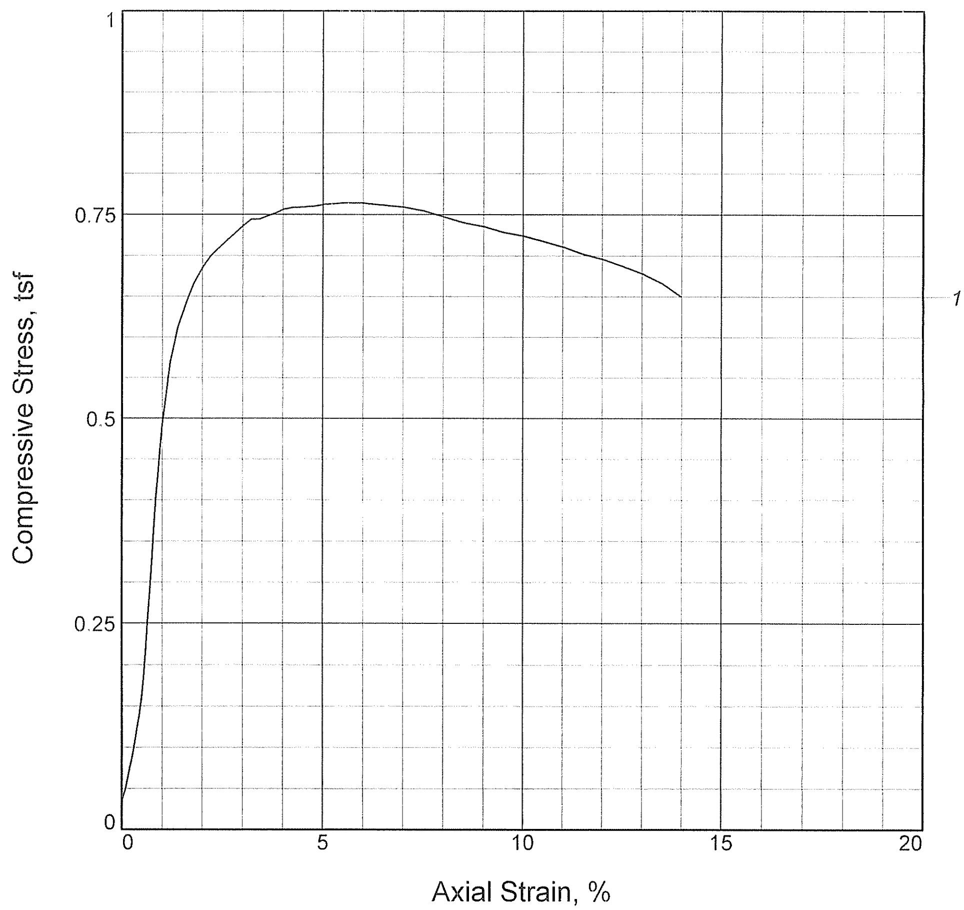
Source of Sample: 06-34 **Depth:** 16-18

Sample Number: 9

UNCONFINED COMPRESSION TEST

Tolunay-Wong Engineers, Inc.

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	0.764			
Undrained shear strength, tsf	0.382			
Failure strain,	5.5			
Strain rate, %/min.	1.00			
Water content, %	40.4			
Wet density, pcf	112.3			
Dry density, pcf	80.0			
Saturation, %	96.8			
Void ratio	1.1470			
Specimen diameter, in.	2.83			
Specimen height, in.	5.92			
Height/diameter ratio	2.09			

Description: Brown and gray FAT CLAY

LL =	PL =	PI =	Assumed GS= 2.75	Type: Undisturbed

Project No.: 03.14.859.44

Date: 12/21/05

Remarks:

Test Method: ASTM D 2166

Pocket pen; tsf: 1.00

Failure type: Slickensided

Figure C-6

Client: United States Army Corps of Engineers

Project: Freeport Placement Area; Contract No. DACW64-03-D-0008 (FY06); Delivery Order No. 0044

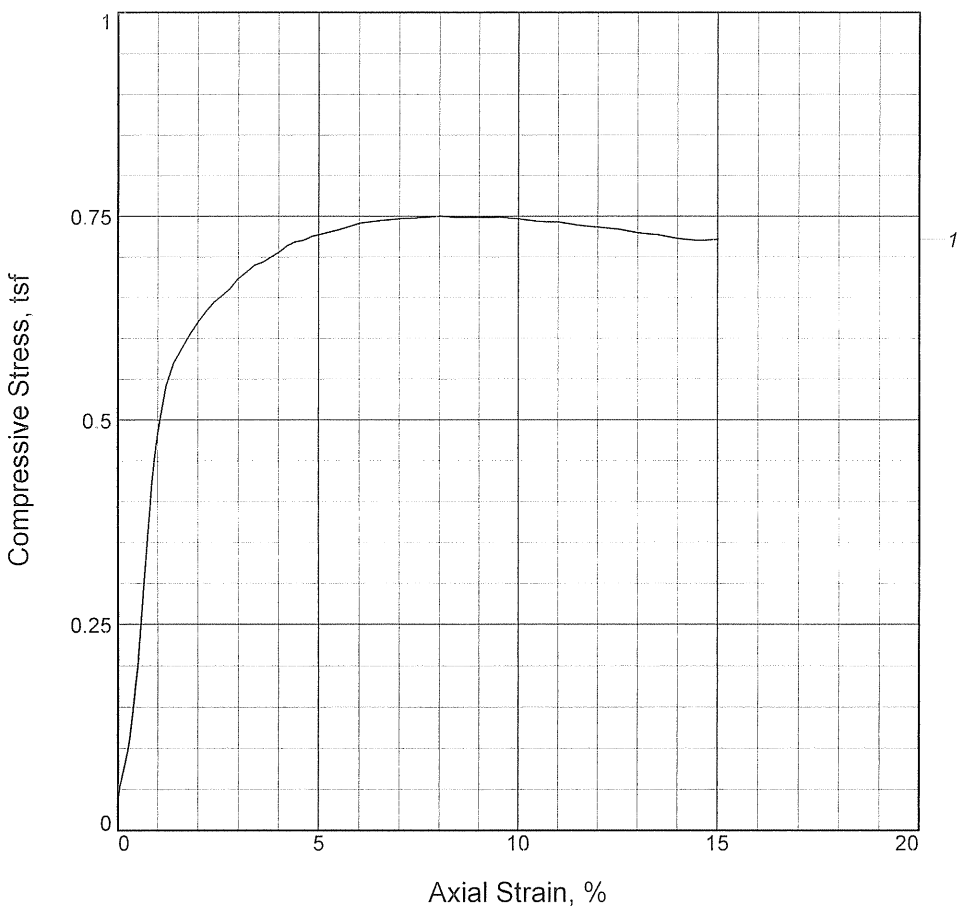
Source of Sample: 06-35 **Depth:** 10-12

Sample Number: 6

UNCONFINED COMPRESSION TEST

Tolunay-Wong Engineers, Inc.

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	0.750			
Undrained shear strength, tsf	0.375			
Failure strain,	8.0			
Strain rate, %/min.	1.00			
Water content, %	36.6			
Wet density, pcf	115.2			
Dry density, pcf	84.4			
Saturation, %	97.2			
Void ratio	1.0348			
Specimen diameter, in.	2.80			
Specimen height, in.	5.93			
Height/diameter ratio	2.12			

Description: Brown and light gray FAT CLAY

LL = 73	**PL =** 26	**PI =** 47	**Assumed GS=** 2.75	**Type:** Undisturbed

Project No.: 03.14.859.44

Date: 12/21/05

Remarks:

Test Method: ASTM D 2166

Pocket pen; tsf: 0.75

Failure type: Bulge

Figure B-7

Client: United States Army Corps of Engineers

Project: Freeport Placement Area; Contract No. DACW64-03-D-0008 (FY06); Delivery Order No. 0044

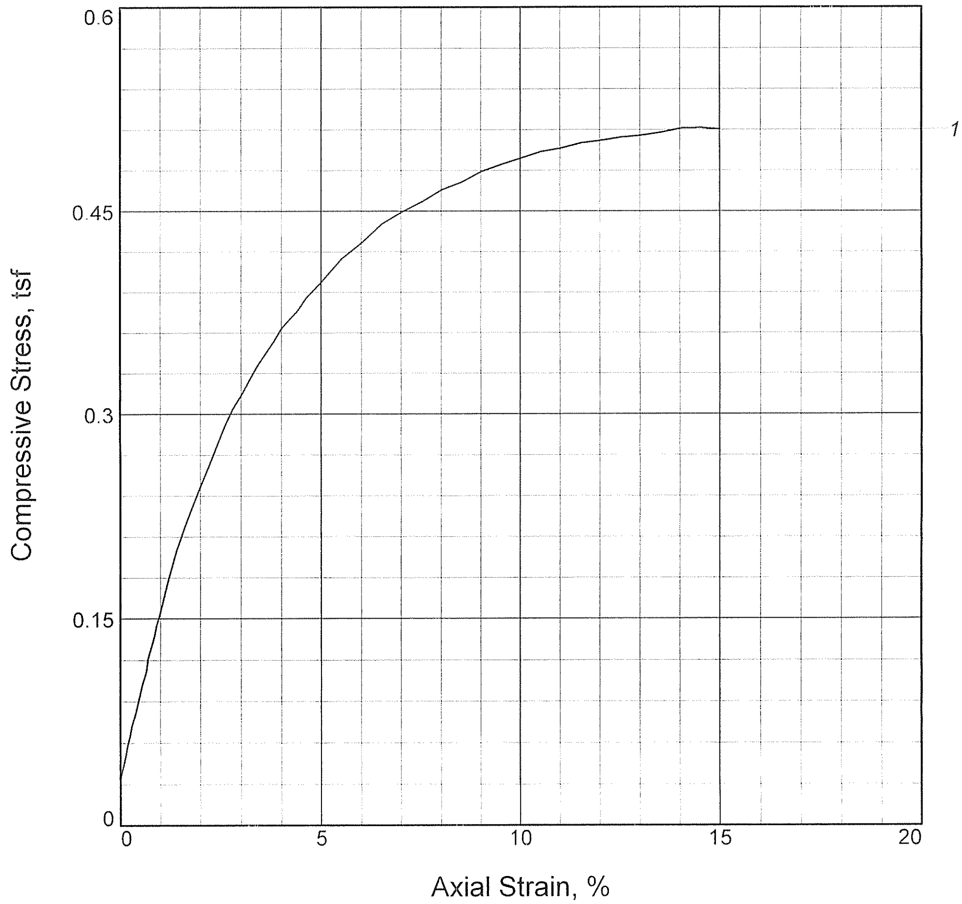
Source of Sample: 06-37 **Depth:** 6-8

Sample Number: 4

UNCONFINED COMPRESSION TEST

Tolunay-Wong Engineers, Inc.

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	0.512			
Undrained shear strength, tsf	0.256			
Failure strain,	14.5			
Strain rate, %/min.	1.00			
Water content, %	26.4			
Wet density, pcf	123.6			
Dry density, pcf	97.8			
Saturation, %	96.2			
Void ratio	0.7558			
Specimen diameter, in.	2.83			
Specimen height, in.	5.70			
Height/diameter ratio	2.02			

Description: Reddish-brown FAT CLAY; sand pockets

LL = 57	**PL =** 22	**PI =** 35	**Assumed GS=** 2.75	**Type:** Undisturbed

Project No.: 03.14.859.44

Date: 12/21/05

Remarks:

Test Method: ASTM D 2166

Pocket pen; tsf: 1.00

Failure type: Bulge

Figure B-8

Client: United States Army Corps of Engineers

Project: Freeport Placement Area; Contract No. DACW64-03-D-0008 (FY06); Delivery Order No. 0044

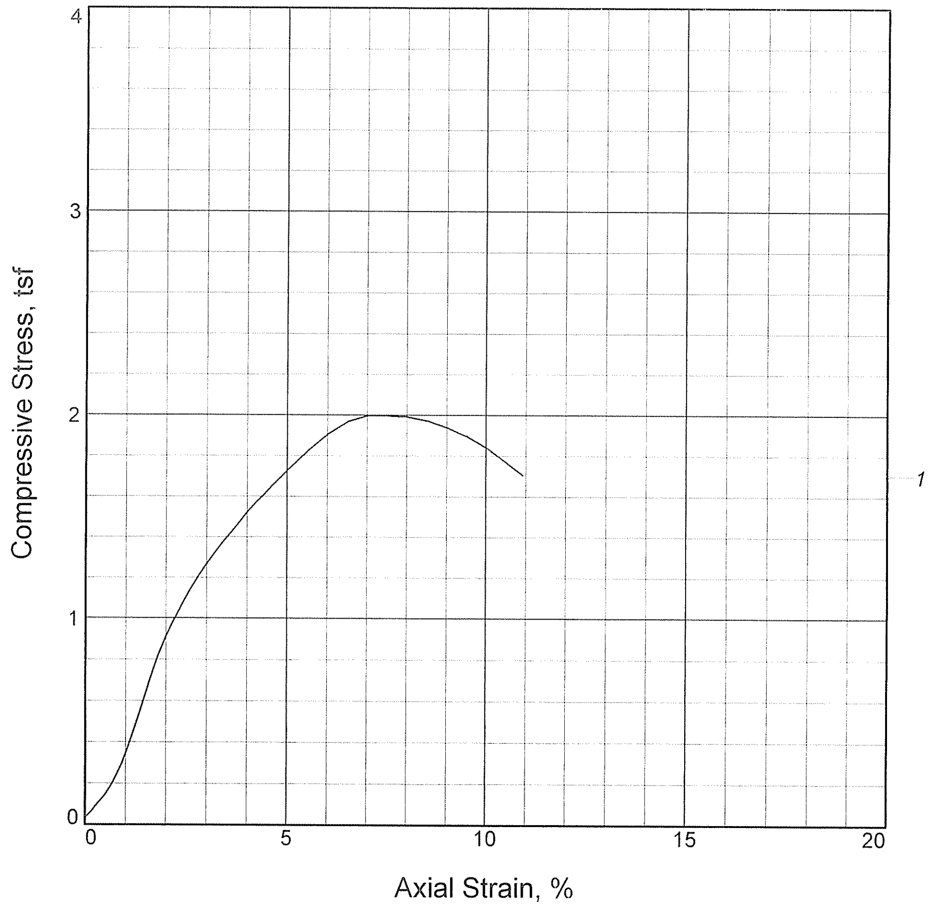
Source of Sample: 06-40 **Depth:** 6-8

Sample Number: 4

UNCONFINED COMPRESSION TEST

Tolunay-Wong Engineers, Inc.

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	1.998			
Undrained shear strength, tsf	0.999			
Failure strain,	7.0			
Strain rate, %/min.	1.00			
Water content, %	22.1			
Wet density, pcf	128.8			
Dry density, pcf	105.6			
Saturation, %	96.8			
Void ratio	0.6262			
Specimen diameter, in.	2.81			
Specimen height, in.	5.76			
Height/diameter ratio	2.05			

Description: Brown and gray FAT CLAY; traces of calcareous

LL =	PL =	PI =	Assumed GS= 2.75	Type: Undisturbed

Project No.: 03.14.859.44

Date: 12/21/05

Remarks:

Test Method: ASTM D 2166

Pocket pen; tsf: 3.25

Failure type: Multiple shear

Figure C-9

Client: United States Army Corps of Engineers

Project: Freeport Placement Area; Contract No. DACW64-03-D-0008 (FY06); Delivery Order No. 0044

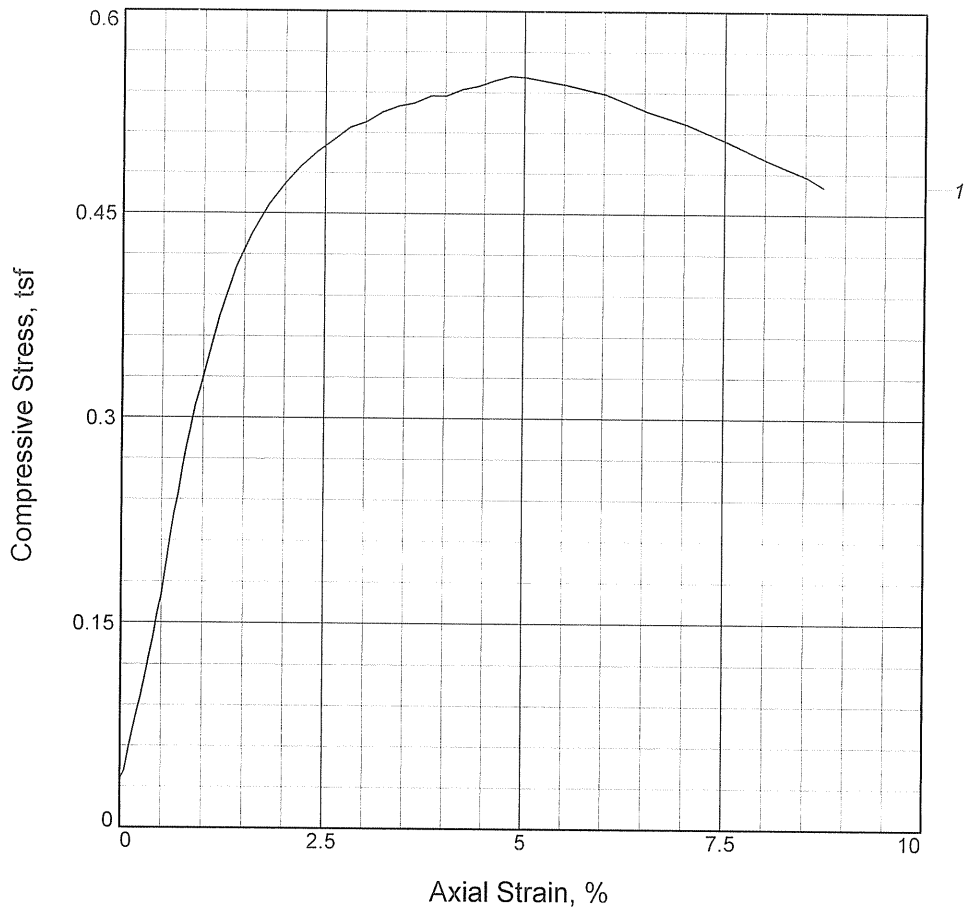
Source of Sample: 06-40 **Depth:** 22-24

Sample Number: 12

UNCONFINED COMPRESSION TEST

Tolunay-Wong Engineers, Inc.

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	0.552			
Undrained shear strength, tsf	0.276			
Failure strain,	4.8			
Strain rate, %/min.	1.00			
Water content, %	39.4			
Wet density, pcf	113.0			
Dry density, pcf	81.0			
Saturation, %	96.9			
Void ratio	1.1190			
Specimen diameter, in.	2.83			
Specimen height, in.	5.91			
Height/diameter ratio	2.09			

Description: Gray and tan FAT CLAY; traces of calcareous

LL = 79	**PL =** 24	**PI =** 55	**Assumed GS=** 2.75	**Type:** Undisturbed

Project No.: 03.14.859.44

Date: 12/21/05

Remarks:

Test Method: ASTM D 2166

Pocket pen; tsf: 0.75

Failure type: Slickensided

Figure B-10

Client: United States Army Corps of Engineers

Project: Freeport Placement Area; Contract No. DACW64-03-D-0008 (FY06); Delivery Order No. 0044

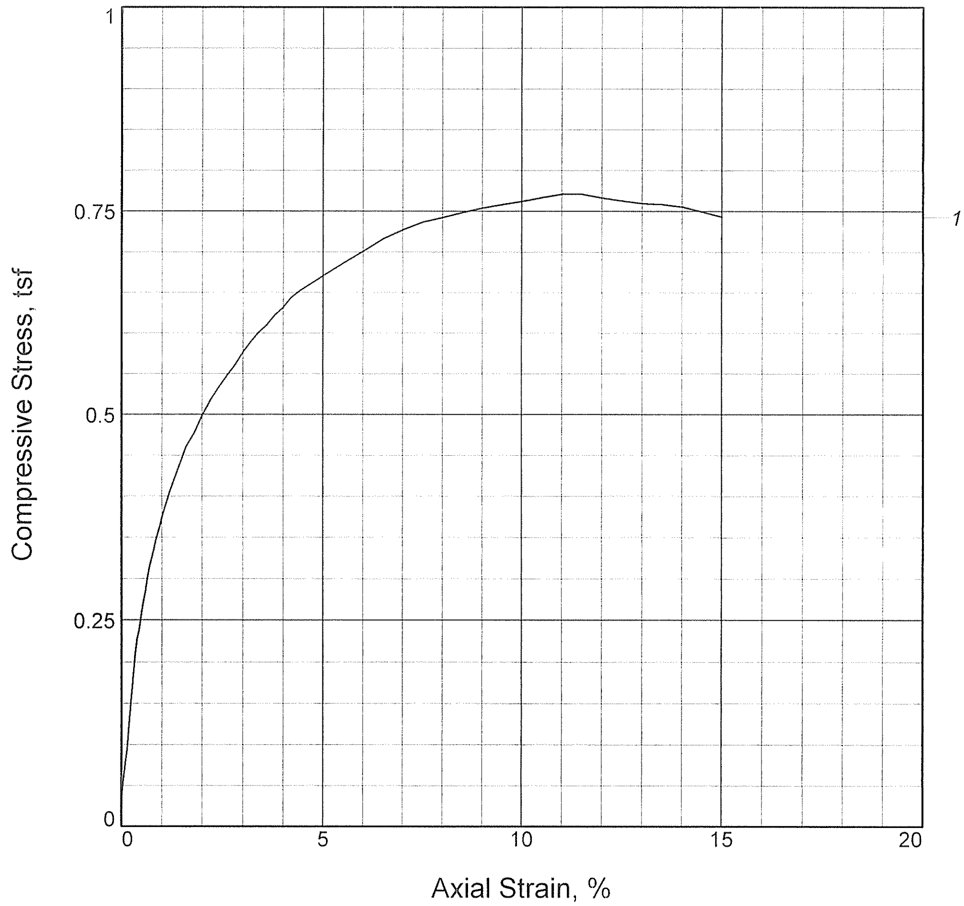
Source of Sample: 06-42 **Depth:** 12-14

Sample Number: 7

UNCONFINED COMPRESSION TEST

Tolunay-Wong Engineers, Inc.

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	0.771			
Undrained shear strength, tsf	0.386			
Failure strain,	11.0			
Strain rate, %/min.	1.00			
Water content, %	27.9			
Wet density, pcf	120.9			
Dry density, pcf	94.5			
Saturation, %	94.1			
Void ratio	0.8163			
Specimen diameter, in.	2.83			
Specimen height, in.	5.89			
Height/diameter ratio	2.08			

Description: Gray and brown FAT CLAY; sand seams

LL = 62	**PL =** 22	**PI =** 40	**Assumed GS=** 2.75	**Type:** Undisturbed

Project No.: 03.14.859.44

Date: 12/21/05

Remarks:

Test Method: ASTM D 2166

Pocket pen; tsf: 0.75

Failure type: Multiple shear

Figure B-11

Client: United States Army Corps of Engineers

Project: Freeport Placement Area; Contract No. DACW64-03-D-0008 (FY06); Delivery Order No. 0044

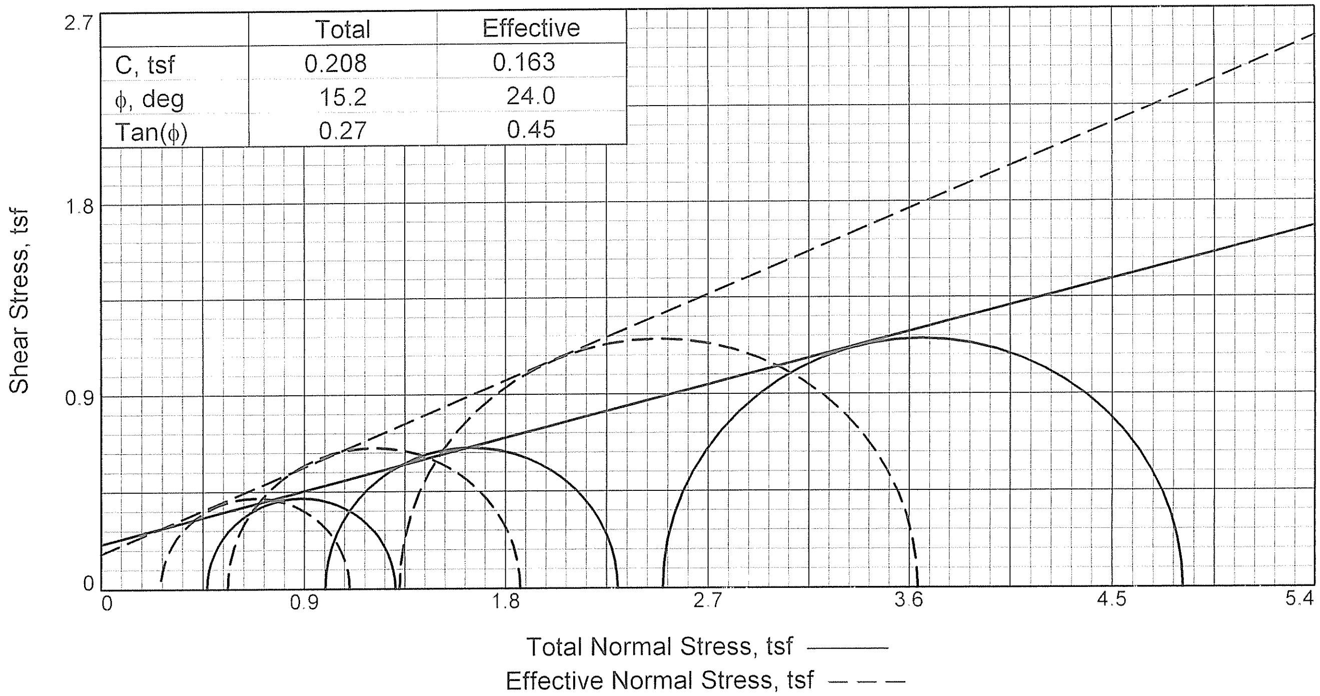
Source of Sample: 06-43 **Depth:** 10-12

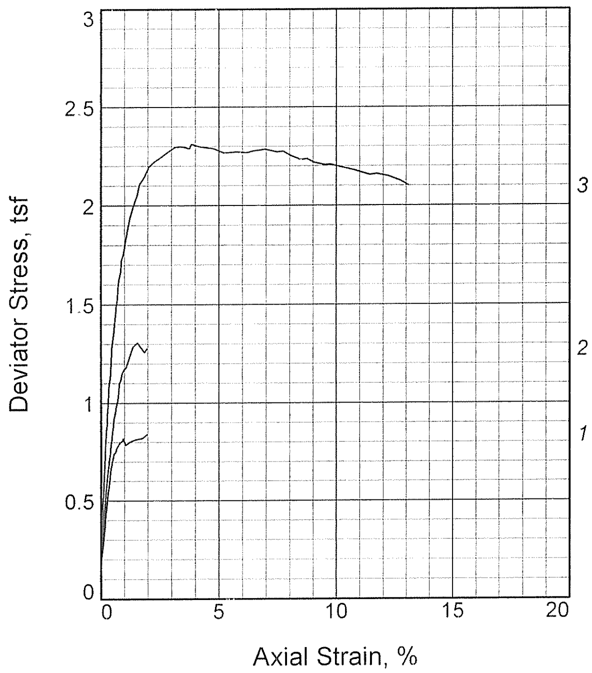
Sample Number: 6

UNCONFINED COMPRESSION TEST

Tolunay-Wong Engineers, Inc.

	Total	Effective
C, tsf	0.208	0.163
ϕ, deg	15.2	24.0
Tan(ϕ)	0.27	0.45





	Sample No.	1	2	3
Initial	Water Content,	26.0	26.0	26.0
	Dry Density, pcf	96.4	96.4	96.4
	Saturation,	93.7	93.7	93.7
	Void Ratio	0.7484	0.7484	0.7484
	Diameter, in.	1.98	1.98	1.98
	Height, in.	4.16	4.16	4.16
At Test	Water Content,	25.2	25.2	25.2
	Dry Density, pcf	96.9	98.3	101.4
	Saturation,	92.0	95.3	102.6
	Void Ratio	0.7400	0.7141	0.6630
	Diameter, in.	1.97	1.98	1.97
	Height, in.	4.16	4.07	3.99
	Strain rate, %/min.	0.02	0.02	0.01
	Eff. Cell Pressure, tsf	0.47	0.99	2.50
	Fail. Stress, tsf	0.84	1.31	2.31
	Excess Pore Pr., tsf	0.20	0.43	1.17
	Strain, %	2.0	1.6	3.8
	Ult. Stress, tsf	0.84	1.31	2.31
	Excess Pore Pr., tsf	0.20	0.43	1.17
	Strain, %	2.0	1.6	3.8
	$\bar{\sigma}_1$ Failure, tsf	1.10	1.87	3.64
	$\bar{\sigma}_3$ Failure, tsf	0.26	0.56	1.33

Type of Test:
CU with Pore Pressures

Sample Type: Undisturbed

Description: Light gray and brown FAT CLAY; traces of calcareous

Assumed Specific Gravity= 2.70

Remarks:
Test Method: ASTM D4767
Pocket pen; tsf: 1.75
Failure type: 45 degree

Client: United States Army Corps of Engineers

Project: Freeport Placement Area
Contract No. DACW64-03-D-0008 (FY 06); Delivery Order No. 0044

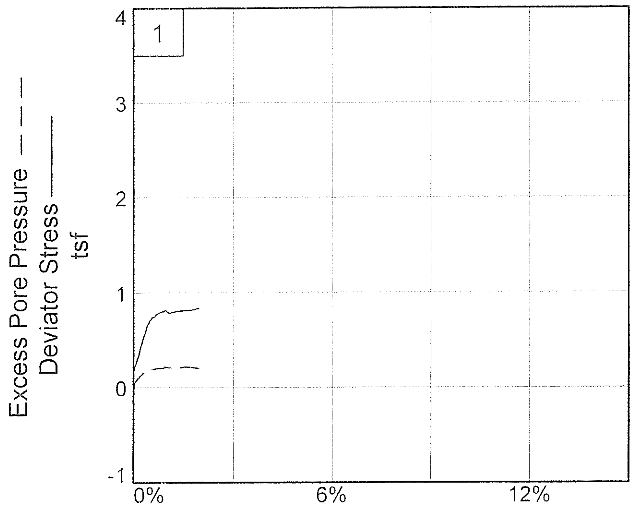
Source of Sample: 06-31 **Depth:** 17-19

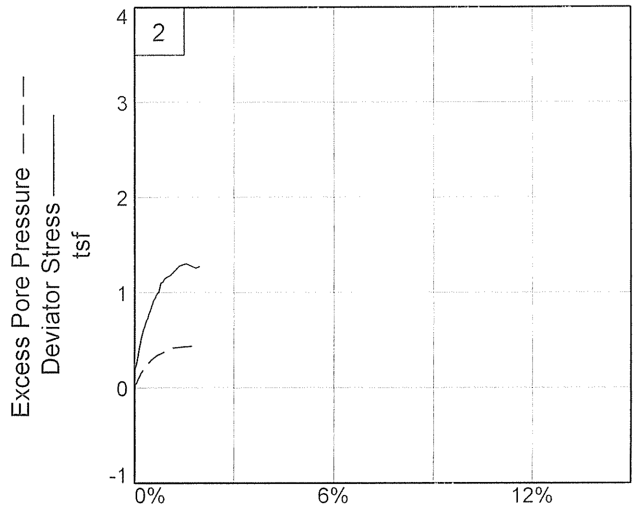
Sample Number: 8

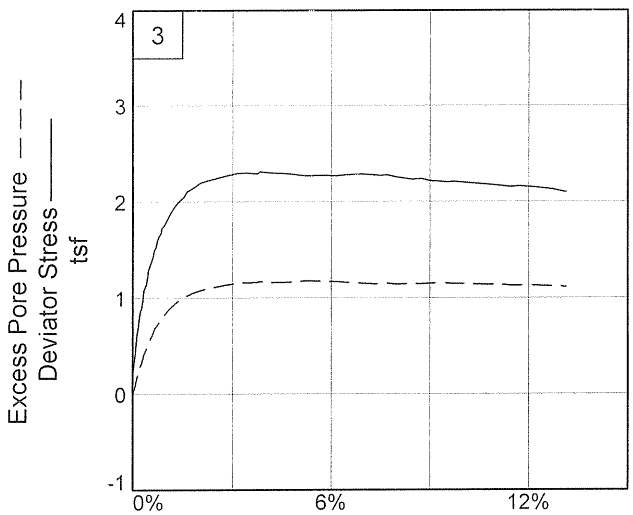
Proj. No.: 03 14.859 44 **Date:** 12/20/05

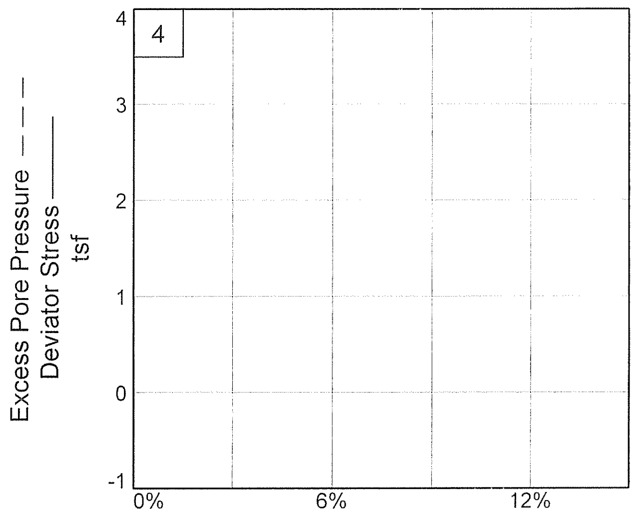
TRIAXIAL SHEAR TEST REPORT

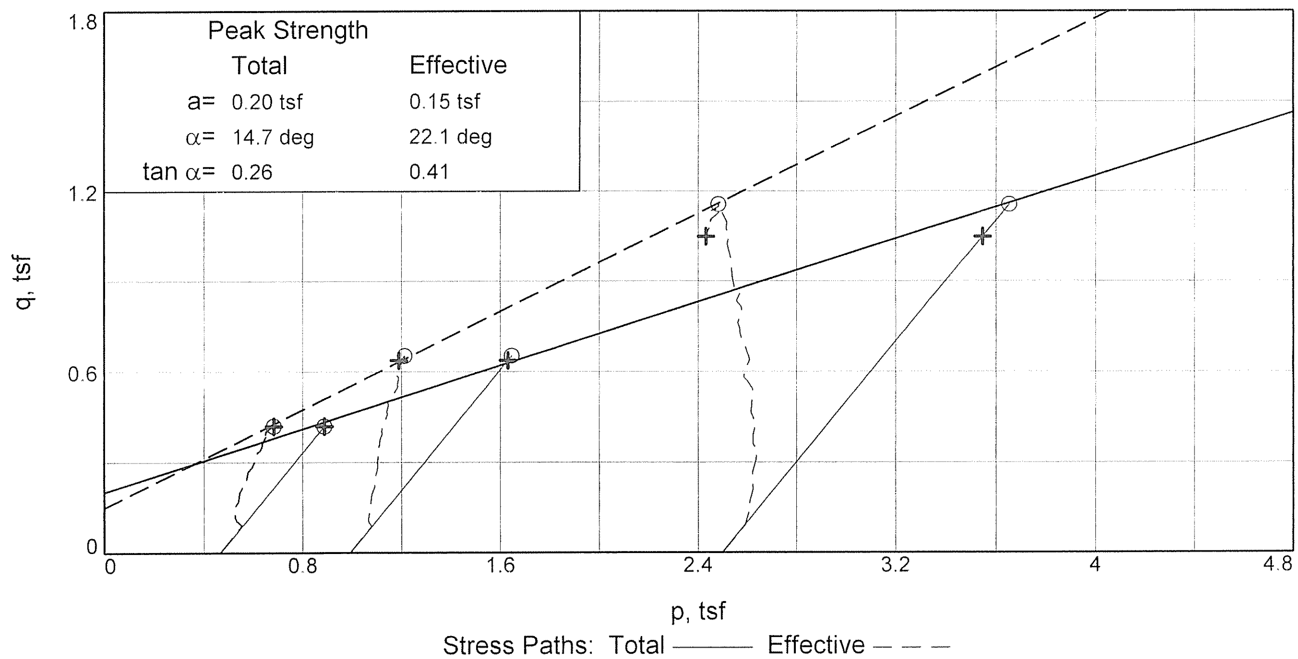
Tolunay-Wong Engineers, Inc.











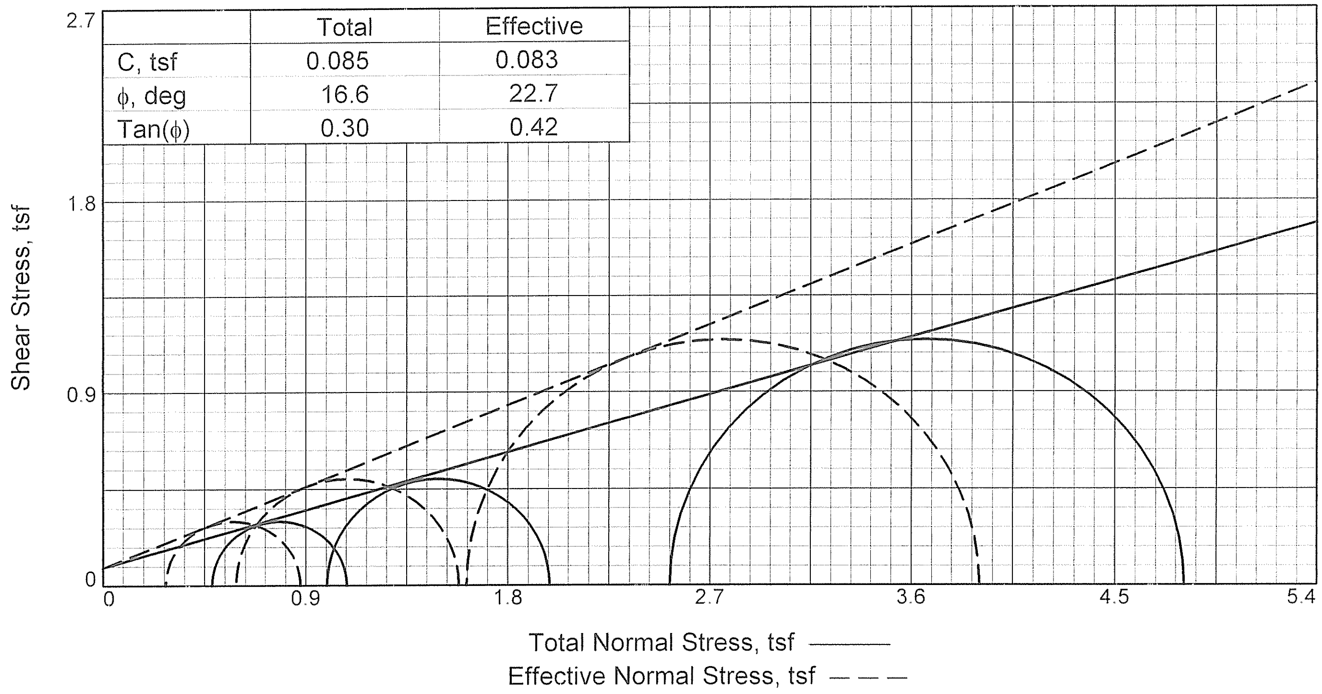
Client: United States Army Corps of Engineers

Project: Freeport Placement Area

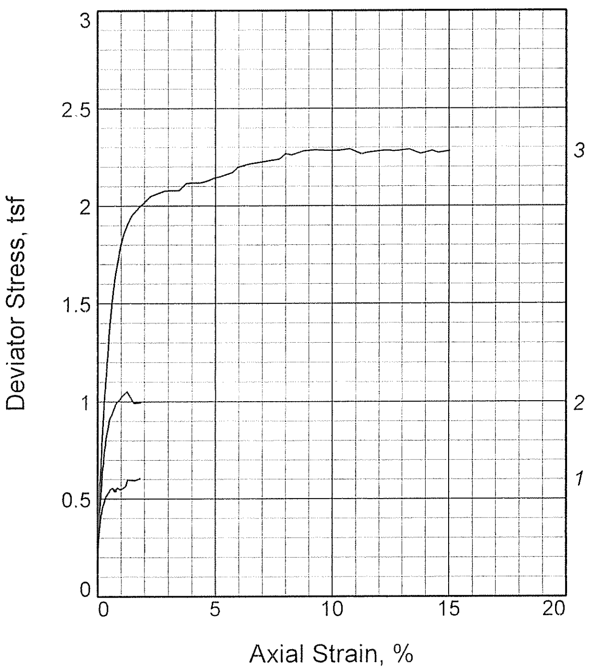
Source of Sample: 06-31 **Depth:** 17-19 **Sample Number:** 8

Project No.: 03.14.859.44

TOLUNAY-WONG ENGINEERS, INC.



	Total	Effective
C, tsf	0.085	0.083
ϕ, deg	16.6	22.7
Tan(ϕ)	0.30	0.42



Sample No.		1	2	3
Initial	Water Content,	25.6	25.6	25.6
	Dry Density, pcf	99.0	99.0	99.0
	Saturation,	98.3	98.3	98.3
	Void Ratio	0.7022	0.7022	0.7022
	Diameter, in.	1.92	1.92	1.92
	Height, in.	4.05	4.05	4.05
At Test	Water Content,	24.9	24.9	24.9
	Dry Density, pcf	98.9	99.9	101.7
	Saturation,	95.4	97.6	102.1
	Void Ratio	0.7039	0.6880	0.6579
	Diameter, in.	1.92	1.93	1.94
	Height, in.	4.05	3.97	3.89
Strain rate, %/min.		0.01	0.02	0.02
Eff. Cell Pressure, tsf		0.48	0.99	2.52
Fail. Stress, tsf		0.60	0.99	2.29
Excess Pore Pr., tsf		0.21	0.40	0.90
Strain, %		1.7	1.8	9.3
Ult. Stress, tsf		0.61	0.99	2.28
Excess Pore Pr., tsf		0.20	0.40	0.79
Strain, %		1.8	1.5	15.0
$\bar{\sigma}_1$ Failure, tsf		0.88	1.58	3.90
$\bar{\sigma}_3$ Failure, tsf		0.28	0.59	1.62

Type of Test:
CU with Pore Pressures

Sample Type: Undisturbed

Description: Light gray and brown FAT CLAY; traces of calcareous

LL= 69 **PL=** 22 **PI=** 47

Assumed Specific Gravity= 2.70

Remarks:
Test Method: ASTM D4767
Pocket pen; tsf: 3.50
Failure type: 45 degree

Client: United States Army Corps of Engineers

Project: Freeport Placement Area
Contract No. DACW64-03-D-0008 (FY 06); Delivery Order No. 0044

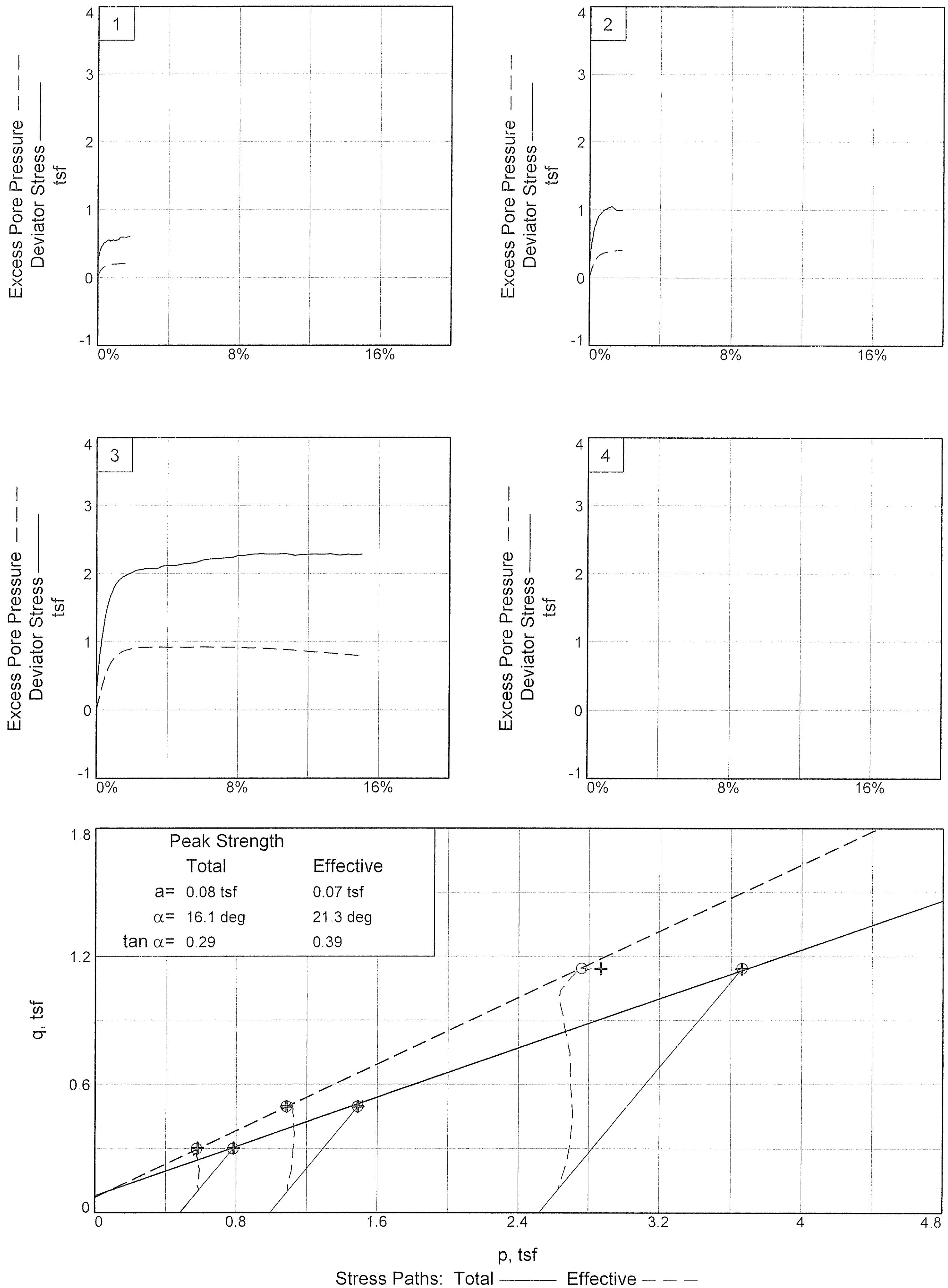
Source of Sample: 06-40 **Depth:** 20-22

Sample Number: 11

Proj. No.: 03 14.859 44 **Date:** 12/20/05

TRIAXIAL SHEAR TEST REPORT

Tolunay-Wong Engineers, Inc.



Client: United States Army Corps of Engineers

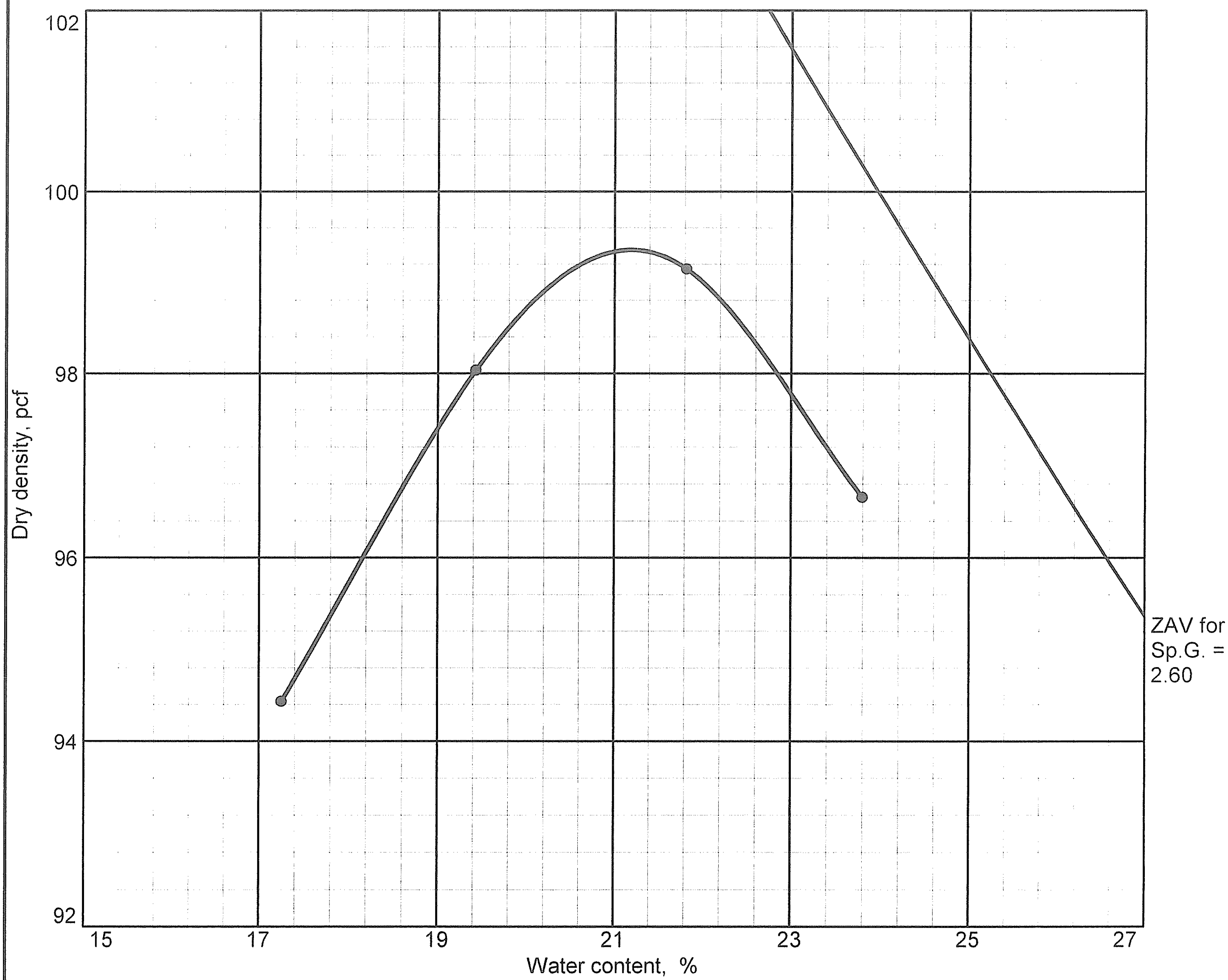
Project: Freeport Placement Area

Source of Sample: 06-40 **Depth:** 20-22 **Sample Number:** 11

Project No.: 03.14.859.44

TOLUNAY-WONG ENGINEERS, INC.

COMPACTION TEST REPORT



Test specification: ASTM D 698-00a Method A Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						
	CH			2.60			0.0	

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 99.4 pcf Optimum moisture = 21.2 %	Dark gray and tan FAT CLAY

Project No. 03.14.859.44 **Client:** United States Army Corps of Engineers

Project: Freeport Placement Area

Contract No. DACW64-03-D-0008 (FY06); Delivery Order No. 0044 **Date:** 01-12-06

● **Source:** Boring Location 40

Tolunay-Wong Engineers, Inc.

Houston, Texas

Remarks:

Preparation Method: Wet

Specific Gravity: Assumed

NED PLAN - FREEPORT HARBOR, TEXAS
Channel Deepening and Selective Widening
Feasibility Study
October 2011 Price Level

Estimated by	J. Lockhart
Designed by	CESWG-EC-PS
Prepared by	U.S. Army Corps of Engineers - Galveston District
Preparation Date	3/28/2012
Effective Date of Pricing	3/28/2012
Estimated Construction Time	Days

Description	UOM	Quantity	DirectCost	ContractCost	ProjectCost
Project Cost Summary Report			**234,256,228**	**239,321,320**	**239,321,320**
01 Contract 1 - Future Ch & half of Outer Bar Ch	**LS**	**1.00**	**66,050,025**	**67,546,887**	**67,546,887**
012 Federal Costs	**LS**	**1.00**	**66,050,025**	**67,546,887**	**67,546,887**
01212 Navigation Ports and Harbors	**LS**	**1.00**	**66,050,025**	**67,546,887**	**67,546,887**
0121201 Mobilization & Demobilization	**LS**	**1.00**	**1,658,000**	**1,658,000**	**1,658,000**
0121202 Hopper Dredging	**CY**	**7,220,000.00**	**58,847,600**	**58,847,600**	**58,847,600**
0121204 Navigation Aids	**LS**	**1.00**	**90,000**	**90,000**	**90,000**
0121203 Sea Turtle Protection	**EA**	**1.00**	**5,454,425**	**6,951,287**	**6,951,287**
02 Contract 2 - Half Outer Bar Ch & Jetty Ch	**LS**	**1.00**	**70,539,585**	**72,118,447**	**72,118,447**
022 Federal Costs	**LS**	**1.00**	**70,539,585**	**72,118,447**	**72,118,447**
02212 Navigation Ports and Harbors	**LS**	**1.00**	**70,539,585**	**72,118,447**	**72,118,447**
0221201 Mobilization & Demobilization	**LS**	**1.00**	**1,726,000**	**1,726,000**	**1,726,000**
0221202 Hopper Dredging	**CY**	**7,737,000.00**	**62,060,360**	**62,060,360**	**62,060,360**
0221203 Sea Turtle Protection	**EA**	**1.00**	**5,753,225**	**7,332,087**	**7,332,087**
0221204 Navigation Aids	**LS**	**1.00**	**1,000,000**	**1,000,000**	**1,000,000**
03 Contract 3 - Lower TB	**LS**	**1.00**	**12,480,200**	**12,480,200**	**12,480,200**
031 Non-Federal Costs	**LS**	**1.00**	**9,488,000**	**9,488,000**	**9,488,000**
03112 NavigationPorts & Harbor	**LS**	**1.00**	**9,488,000**	**9,488,000**	**9,488,000**
031201 Dredging for Berthing Areas	**CY**	**99,000.00**	**1,188,000**	**1,188,000**	**1,188,000**
031202 Upgrade Berthing Area	**EA**	**1.00**	**8,300,000**	**8,300,000**	**8,300,000**
032 Federal Costs	**LS**	**1.00**	**2,992,200**	**2,992,200**	**2,992,200**
03212 Navigation Ports and Harbors	**LS**	**1.00**	**2,992,200**	**2,992,200**	**2,992,200**
0321201 Mobilization & Demobilization	**LS**	**1.00**	**480,000**	**480,000**	**480,000**
0321202 Pipeline Dredging	**CY**	**318,000.00**	**2,512,200**	**2,512,200**	**2,512,200**
05 Cont 5 - Ch to BRZPT through BRZPT TB and PA 8	**LS**	**1.00**	**44,674,731**	**45,629,065**	**45,629,065**
051 Non-Federal Costs	**LS**	**1.00**	**16,428,000**	**16,428,000**	**16,428,000**

Description	UOM	Quantity	DirectCost	ContractCost	ProjectCost
05112 NavigationPorts & Harbor	**LS**	**1.00**	**16,428,000**	**16,428,000**	**16,428,000**
0511201 Dredging for Berthing Areas	**CY**	**144,000.00**	**1,728,000**	**1,728,000**	**1,728,000**
0511202 Upgrade Berthing Area	**EA**	**2.00**	**14,700,000**	**14,700,000**	**14,700,000**
052 Federal Costs	**LS**	**1.00**	**28,246,731**	**29,201,065**	**29,201,065**
05212 Navigation Ports and Harbors	**LS**	**1.00**	**28,246,731**	**29,201,065**	**29,201,065**
0521201 Mobilization & Demobilization	**LS**	**1.00**	**600,000**	**600,000**	**600,000**
0521202 Pipeline Dredging	**CY**	**2,316,000.00**	**24,179,040**	**24,179,040**	**24,179,040**
0521203 PA 8	**EA**	**1.00**	**3,467,691**	**4,422,025**	**4,422,025**
06 Cont 6 - Ch to Upper TB throught Uper TB and, PA 9	**LS**	**1.00**	**29,180,010**	**30,186,930**	**30,186,930**
061 Non-Federal Costs	**LS**	**1.00**	**19,104,000**	**19,104,000**	**19,104,000**
06112 NavigationPorts & Harbor	**LS**	**1.00**	**19,104,000**	**19,104,000**	**19,104,000**
0611201 Dredging for Berthing Areas	**CY**	**317,000.00**	**3,804,000**	**3,804,000**	**3,804,000**
0611202 Upgrade Berthing Area	**EA**	**2.00**	**15,300,000**	**15,300,000**	**15,300,000**
062 Federal Costs	**LS**	**1.00**	**10,076,010**	**11,082,930**	**11,082,930**
06212 Navigation Ports and Harbors	**LS**	**1.00**	**10,076,010**	**11,082,930**	**11,082,930**
0621201 Mobilization & Demobilization	**LS**	**1.00**	**550,000**	**550,000**	**550,000**
0621202 Pipeline Dredging	**CY**	**1,037,000.00**	**5,867,240**	**5,867,240**	**5,867,240**
0621203 PA 9	**EA**	**1.00**	**3,658,770**	**4,665,690**	**4,665,690**
07 Contract 7 -Stauffer Ch	**LS**	**1.00**	**11,229,520**	**11,229,520**	**11,229,520**
071 Non-Federal Costs	**LS**	**1.00**	**1,092,000**	**1,092,000**	**1,092,000**
03112 NavigationPorts & Harbor	**LS**	**1.00**	**1,092,000**	**1,092,000**	**1,092,000**
031201 Dredging for Berthing Areas	**CY**	**91,000.00**	**1,092,000**	**1,092,000**	**1,092,000**
072 Federal Costs	**LS**	**1.00**	**10,137,520**	**10,137,520**	**10,137,520**
07212 Navigation Ports and Harbors	**LS**	**1.00**	**10,137,520**	**10,137,520**	**10,137,520**
0721201 Mobilization & Demobilization	**LS**	**1.00**	**550,000**	**550,000**	**550,000**
0721202 Pipeline Dredging	**CY**	**1,814,000.00**	**9,587,520**	**9,587,520**	**9,587,520**

Description	UOM	Quantity	DirectCost	ContractCost	ProjectCost
08 Contract 8- Mitigation	**LS**	**1.00**	**102,157**	**130,271**	**130,271**
082 Federal Costs	**LS**	**1.00**	**102,157**	**130,271**	**130,271**
08206 Fish & Wildlife Facilities	**ACR**	**12.00**	**102,157**	**130,271**	**130,271**
0820601 Tallow Removal	**ACR**	**12.00**	**10,052**	**12,818**	**12,818**
0820603 Planting Forest Seedlings	**EA**	**1,800.00**	**18,000**	**22,954**	**22,954**
0820604 Grassland	**ACR**	**8.00**	**34,877**	**44,475**	**44,475**
0820602 Pond Creation	**ACR**	**3.00**	**39,229**	**50,025**	**50,025**

Description	Page
Project Cost Summary Report	**1**
01 Contract 1 - Future Ch & half of Outer Bar Ch	1
012 Federal Costs	1
01212 Navigation Ports and Harbors	1
0121201 Mobilization & Demobilization	1
0121202 Hopper Dredging	1
0121204 Navigation Aids	1
0121203 Sea Turtle Protection	1
02 Contract 2 - Half Outer Bar Ch & Jetty Ch	1
022 Federal Costs	1
02212 Navigation Ports and Harbors	1
0221201 Mobilization & Demobilization	1
0221202 Hopper Dredging	1
0221203 Sea Turtle Protection	1
0221204 Navigation Aids	1
03 Contract 3 - Lower TB	1
031 Non-Federal Costs	1
03112 NavigationPorts & Harbor	1
031201 Dredging for Berthing Areas	1
031202 Upgrade Berthing Area	1
032 Federal Costs	1
03212 Navigation Ports and Harbors	1
0321201 Mobilization & Demobilization	1
0321202 Pipeline Dredging	1
05 Cont 5 - Ch to BRZPT through BRZPT TB and PA 8	1
051 Non-Federal Costs	1
05112 NavigationPorts & Harbor	1
05112 NavigationPorts & Harbor	2
0511201 Dredging for Berthing Areas	2
0511202 Upgrade Berthing Area	2
052 Federal Costs	2
05212 Navigation Ports and Harbors	2
0521201 Mobilization & Demobilization	2
0521202 Pipeline Dredging	2
0521203 PA 8	2
06 Cont 6 - Ch to Upper TB throught Uper TB and, PA 9	2
061 Non-Federal Costs	2
06112 NavigationPorts & Harbor	2
0611201 Dredging for Berthing Areas	2
0611202 Upgrade Berthing Area	2
062 Federal Costs	2
06212 Navigation Ports and Harbors	2

Description	Page
0621201 Mobilization & Demobilization	2
0621202 Pipeline Dredging	2
0621203 PA 9	2
07 Contract 7 -Stauffer Ch	2
071 Non-Federal Costs	2
03112 NavigationPorts & Harbor	2
031201 Dredging for Berthing Areas	2
072 Federal Costs	2
07212 Navigation Ports and Harbors	2
0721201 Mobilization & Demobilization	2
0721202 Pipeline Dredging	2
08 Contract 8- Mitigation	2
08 Contract 8- Mitigation	3
082 Federal Costs	3
08206 Fish & Wildlife Facilities	3
0820601 Tallow Removal	3
0820603 Planting Forest Seedlings	3
0820604 Grassland	3
0820602 Pond Creation	3

LPP PLAN - FREEPORT HARBOR, TEXAS
Channel Deepening and Widening
Feasibility Study
October 2011 Price Level

Estimated by	J. Lockhart
Designed by	CESWG-EC-PS
Prepared by	U.S. Army Corps of Engineers - Galveston District
Preparation Date	3/29/2012
Effective Date of Pricing	3/29/2012
Estimated Construction Time	Days

Description	UOM	Quantity	DirectCost	ContractCost	ProjectCost
Project Cost Summary Report			**181,261,468**	**185,396,562**	**185,396,562**
01 Contract 1 - Future Ch & Half of Outer Bar Ch	**LS**	**1.00**	**36,638,300**	**37,626,474**	**37,626,474**
012 Federal Costs	**LS**	**1.00**	**36,638,300**	**37,626,474**	**37,626,474**
01212 Navigation Ports and Harbors	**LS**	**1.00**	**36,638,300**	**37,626,474**	**37,626,474**
0121201 Mobilization & Demobilization	**LS**	**1.00**	**1,900,000**	**1,900,000**	**1,900,000**
0121202 Hopper Dredging	**CY**	**3,940,000.00**	**31,055,150**	**31,055,150**	**31,055,150**
0121204 Navigation Aids	**LS**	**1.00**	**90,000**	**90,000**	**90,000**
0121203 Sea Turtle Protection	**EA**	**1.00**	**3,593,150**	**4,581,324**	**4,581,324**
02 Contract 2 - Half Outer Bar Ch & Jetty Ch	**LS**	**1.00**	**54,041,660**	**55,231,847**	**55,231,847**
022 Federal Costs	**LS**	**1.00**	**54,041,660**	**55,231,847**	**55,231,847**
02212 Navigation Ports and Harbors	**LS**	**1.00**	**54,041,660**	**55,231,847**	**55,231,847**
0221201 Mobilization & Demobilization	**LS**	**1.00**	**1,900,000**	**1,900,000**	**1,900,000**
0221202 Hopper Dredging	**CY**	**5,793,000.00**	**46,813,960**	**46,813,960**	**46,813,960**
0221203 Sea Turtle Protection	**EA**	**1.00**	**4,327,700**	**5,517,887**	**5,517,887**
0221204 Navigation Aids	**LS**	**1.00**	**1,000,000**	**1,000,000**	**1,000,000**
03 Contract 3 - Lower TB	**LS**	**1.00**	**11,812,840**	**11,812,840**	**11,812,840**
031 Non-Federal Costs	**LS**	**1.00**	**9,488,000**	**9,488,000**	**9,488,000**
03112 NavigationPorts & Harbor	**EA**	**1.00**	**9,488,000**	**9,488,000**	**9,488,000**
031201 Dredging for Berthing Areas	**CY**	**99,000.00**	**1,188,000**	**1,188,000**	**1,188,000**
031202 Upgrade Berthing Area	**EA**	**1.00**	**8,300,000**	**8,300,000**	**8,300,000**
032 Federal Costs	**LS**	**1.00**	**2,324,840**	**2,324,840**	**2,324,840**
03212 Navigation Ports and Harbors	**LS**	**1.00**	**2,324,840**	**2,324,840**	**2,324,840**
0321201 Mobilization & Demobilization	**LS**	**1.00**	**665,000**	**665,000**	**665,000**
0321202 Pipeline Dredging	**CY**	**208,000.00**	**1,659,840**	**1,659,840**	**1,659,840**
05 Cont 5 - Ch to BRZPT through BRZPT TB and PA 8	**LS**	**1.00**	**38,527,891**	**39,466,569**	**39,466,569**
051 Non-Federal Costs	**LS**	**1.00**	**16,428,000**	**16,428,000**	**16,428,000**

Description	UOM	Quantity	DirectCost	ContractCost	ProjectCost
05112 NavigationPorts & Harbor	**EA**	**1.00**	**16,428,000**	**16,428,000**	**16,428,000**
0511201 Dredging for Berthing Areas	**CY**	**144,000.00**	**1,728,000**	**1,728,000**	**1,728,000**
0511202 Upgrade Berthing Area	**EA**	**2.00**	**14,700,000**	**14,700,000**	**14,700,000**
052 Federal Costs	**LS**	**1.00**	**22,099,891**	**23,038,569**	**23,038,569**
05212 Navigation Ports and Harbors	**LS**	**1.00**	**22,099,891**	**23,038,569**	**23,038,569**
0521201 Mobilization & Demobilization	**LS**	**1.00**	**700,000**	**700,000**	**700,000**
0521202 Pipeline Dredging	**CY**	**2,916,000.00**	**17,932,200**	**17,932,200**	**17,932,200**
0521203 PA 8	**EA**	**1.00**	**3,467,691**	**4,406,369**	**4,406,369**
06 Cont 6 - Ch to Upper TB throught Uper TB and PA 9	**LS**	**1.00**	**28,909,100**	**29,899,502**	**29,899,502**
061 Non-Federal Costs	**LS**	**1.00**	**19,104,000**	**19,104,000**	**19,104,000**
06112 NavigationPorts & Harbor	**EA**	**1.00**	**19,104,000**	**19,104,000**	**19,104,000**
0611201 Dredging for Berthing Areas	**CY**	**317,000.00**	**3,804,000**	**3,804,000**	**3,804,000**
0611202 Upgrade Berthing Area	**EA**	**2.00**	**15,300,000**	**15,300,000**	**15,300,000**
062 Federal Costs	**LS**	**1.00**	**9,805,100**	**10,795,502**	**10,795,502**
06212 Navigation Ports and Harbors	**LS**	**1.00**	**9,805,100**	**10,795,502**	**10,795,502**
0621201 Mobilization & Demobilization	**LS**	**1.00**	**550,000**	**550,000**	**550,000**
0621202 Pipeline Dredging	**CY**	**881,000.00**	**5,596,330**	**5,596,330**	**5,596,330**
0621203 PA 9	**EA**	**1.00**	**3,658,770**	**4,649,172**	**4,649,172**
07 Contract 7 -Stauffer Ch	**LS**	**1.00**	**11,229,520**	**11,229,520**	**11,229,520**
071 Non-Federal Costs	**LS**	**1.00**	**1,092,000**	**1,092,000**	**1,092,000**
03112 NavigationPorts & Harbor	**LS**	**1.00**	**1,092,000**	**1,092,000**	**1,092,000**
031201 Dredging for Berthing Areas	**CY**	**91,000.00**	**1,092,000**	**1,092,000**	**1,092,000**
072 Federal Costs	**LS**	**1.00**	**10,137,520**	**10,137,520**	**10,137,520**
07212 Navigation Ports and Harbors	**LS**	**1.00**	**10,137,520**	**10,137,520**	**10,137,520**
0721201 Mobilization & Demobilization	**LS**	**1.00**	**550,000**	**550,000**	**550,000**
0721202 Pipeline Dredging	**CY**	**1,814,000.00**	**9,587,520**	**9,587,520**	**9,587,520**

Description	UOM	Quantity	DirectCost	ContractCost	ProjectCost
08 Contract 8- Mitigation	**LS**	**1.00**	**102,157**	**129,810**	**129,810**
082 Federal Costs	**LS**	**1.00**	**102,157**	**129,810**	**129,810**
08206 Fish & Wildlife Facilities	**ACR**	**12.00**	**102,157**	**129,810**	**129,810**
0820601 Tallow Removal	**ACR**	**12.00**	**10,052**	**12,772**	**12,772**
0820603 Planting Forest Seedlings	**EA**	**1,800.00**	**18,000**	**22,872**	**22,872**
0820604 Grassland	**ACR**	**8.00**	**34,877**	**44,318**	**44,318**
0820602 Pond Creation	**ACR**	**3.00**	**39,229**	**49,848**	**49,848**

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01212 Navigation Ports and Harbors	1
0121201 Mobilization & Demobilization	1
0121202 Hopper Dredging	1
0121204 Navigation Aids	1
0121203 Sea Turtle Protection	1
02 Contract 2 - Half Outer Bar Ch & Jetty Ch	1
022 Federal Costs	1
02212 Navigation Ports and Harbors	1
0221201 Mobilization & Demobilization	1
0221202 Hopper Dredging	1
0221203 Sea Turtle Protection	1
0221204 Navigation Aids	1
03 Contract 3 - Lower TB	1
031 Non-Federal Costs	1
03112 NavigationPorts & Harbor	1
031201 Dredging for Berthing Areas	1
031202 Upgrade Berthing Area	1
032 Federal Costs	1
03212 Navigation Ports and Harbors	1
0321201 Mobilization & Demobilization	1
0321202 Pipeline Dredging	1
05 Cont 5 - Ch to BRZPT through BRZPT TB and PA 8	1
051 Non-Federal Costs	1
05112 NavigationPorts & Harbor	1
05112 NavigationPorts & Harbor	2
0511201 Dredging for Berthing Areas	2
0511202 Upgrade Berthing Area	2
052 Federal Costs	2
05212 Navigation Ports and Harbors	2
0521201 Mobilization & Demobilization	2
0521202 Pipeline Dredging	2
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06 Cont 6 - Ch to Upper TB throught Uper TB and PA 9	2
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Attachment

Cost Engineering Documentation

US Army Corps
of Engineers®

FREEPORT HARBOR, TEXAS
CHANNEL IMPROVEMENT PROJECT
(WIDENING AND DEEPENING)

FEASIBILITY RISK ANALYSIS REPORT
FOR
GALVESTON DISTRICT, TEXAS

REPORT UPDATE - 2012

Prepared for:

U.S. Army Corps of Engineers, Galveston District

Prepared by:

U.S. Army Corps of Engineers, Walla Walla District
Cost Engineering Branch

Date: April 27, 2012

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DRAFT

EXECUTIVE SUMMARY

REPORT PURPOSE

The purpose of this risk analysis report is to document the results of the Cost and Schedule Risk Analysis (CSRA) performed for the Freeport Harbor Widening and Deepening Feasibility Study under development by the U.S. Army Corps of Engineers (USACE), Galveston District.

PROJECT BACKGROUND

The purpose of the 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 traffic in the channel. The study also identified new economic benefits associated with proposed channel modifications and recommends alternatives that maximize these benefits. The study was conducted to determine if navigation problems currently being experienced at Freeport Harbor are in the Federal interest and to provide documentation needed to recommend Congressional authorization and funding for construction of that project.

The feasibility study resulted in choosing the Locally Preferred Plan (LPP). The chosen project reaches were then placed into separate contracts that equate to an approximate 1-year duration each. Those separate contracts were then studied within the CSRA framework. Note that the choice to establish acquisition strategy and contract duration at this stage greatly diminished certain risks. Those contracts studied are:

- Contract 1: Future Channel Extension and One-Half of the Outer Bar Channel
- Contract 2: One-Half Outer Bar Channel and Jetty Channel
- Contract 3: Lower Turning Basin
- Contract 4: Real Estate PA8
- Contract 5: Channel to Brazosport through Turning Basin
- Contract 6: Channel to Upper Turning Basin through Upper Turning Basin
- Contract 7: Stauffer Channel - Lower and Upper Reach
- Contract 8: Environmental Mitigation

REPORT SCOPE

The scope of the risk analysis report is to reflect the feasibility study and to calculate and present the cost contingencies at the 80 percent (P80) confidence level using the risk analysis processes as mandated by USACE Engineer Regulation (ER) 1110-2-1150, Engineering and Design for Civil Works, ER 1110-2-1302, Civil Works Cost Engineering, and Engineer Technical Letter 1110-2-573, Construction Cost Estimating

Guide for Civil Works. The report presents the contingency results for both cost and schedule risks for all construction features at feasibility level development.

RISK ANALYSIS PROCESS

The risk analysis process uses *Monte Carlo* techniques to determine probabilities and contingency. The *Monte Carlo* techniques are facilitated computationally by a commercially available risk analysis software package (Crystal Ball), which is an add-in to Microsoft Excel. Cost estimates are packaged into an Excel format and used directly for cost risk analysis purposes.

Since the dredging estimates for this project were developed within the USACE Cost Engineering Dredge Estimating Program (CEDEP), which is Excel based, the risk analysis process used the CEDEP as the risk model basis, incorporating both cost and schedule. Contracts 4 and 8 (Real Estate and Environmental Mitigation) are minimal costs and were transferred into Excel to support the risk analyses, respectively.

Specifically related to this project, it became apparent that the contracts related to dredging carried similar risks (Contracts 1, 2, 3, 5, 6, and 7). For this reason, the dredging contracts utilized the same risk events identified within the risk register to support the risk models and resulting contingencies. A separate risk register was developed for Contract 8 (Environmental Mitigation).

CONTINGENCY RESULTS

The USACE Cost Engineering Technical Center of Expertise (TCX) for Civil Works recommends risk analyses output reflect the P80 confidence level in successfully completing the project. The following table reflects those results for the eight specific contracts. It is these contingencies that are reflected within the Total Project Cost Summary.

Table ES-1. Contract Contingency Results - 80 Percent Confidence

Contract No.	Contract Description/Title	Type of Work	Contingency
Contract 1	Future Channel Extension and One-Half Outer Bar Channel	Dredging	24%
Contract 2	One-Half Outer Bar Channel and Jetty Channel	Dredging	24%
Contract 3	Lower Turning Basin	Dredging	24%
Contract 4	Real Estate for PA8		24%
Contract 5	Channel to Brazosport through Turning Basin	Dredging	24%
Contract 6	Channel to Upper Turning Basin through Upper Turning Basin	Dredging	24%
Contract 7	Stauffer Channel - Lower and Upper Reach	Dredging	24%
Contract 8	Environmental Mitigation	Mitigation	24%

Note: Contingency % reflects an 80% confidence level.

<u>Dredging Risks</u>: While dredging risks varied between the six contracts, similar risks were found:

- Fuel price fluctuations and volatility.
- Contractor overhead assumptions and bidding climate/competition.
- Uncertain dredge material classifications, which can impact productivity assumptions.
- Dredging prism that defines the quantities dredged.

<u>Environmental Mitigation Risks</u>: The four most common risk concerns related to the Environmental Mitigation contract, carrying the greater risks were:

- Bidding climate and competition.
- Inflation rates in the local area potentially exceeding the annual Office of Management and Budget rates.
- Potential for scope changes before and after construction contract award.
- Work in the out years subject to cost variances not captured within the estimate or the risk analysis.

1. PURPOSE

The purpose of this report is to document the results of the Cost and Schedule Risk Analysis (CSRA) performed for the Freeport Harbor Widening and Deepening Feasibility Study under development by the U.S. Army Corps of Engineers (USACE), Galveston District.

2. BACKGROUND

The original project for Federal channel improvement at Freeport Harbor 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 Act 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 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. Greater depth and width were authorized by Congress in 1970 (Section 101 of RHA of 1970, Public Law 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 USACE in 1978. In 1978, Seaway Pipeline, Inc., under a Department of Army permit, widened the entrance (outer bar) channel to 400 feet and the jetty channel to 230 feet.

The purpose of the feasibility study was 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 traffic in the channel. The study also identified new economic benefits associated with proposed channel modifications and recommends alternatives that maximize these benefits. The study was conducted to determine if navigation problems currently being experienced at Freeport Harbor are in the Federal interest and to provide documentation needed to recommend Congressional authorization and funding for construction of that project.

3. REPORT SCOPE

The scope of the risk analysis report is to calculate and present the cost contingencies at the 80 percent confidence level using the risk analysis processes as mandated by USACE Engineer Regulation (ER) 1110-2-1150, Engineering and Design for Civil Works, ER 1110-2-1302, Civil Works Cost Engineering, and Engineer Technical Letter 1110-2-573, Construction Cost Estimating Guide for Civil Works. The report presents the contingency results for both cost and schedule risks for all construction features.

3.1 Project Scope

For this feasibility study of the widening and deepening of the Freeport Harbor channel, two project estimates were developed: (1) National Economic Development Plan (NED) and (2) Locally Preferred Plan (LPP). The current existing channel is 45 feet by 400 feet. See table 1 for a description of the project channel reaches for the differences between both proposed plans.

Table 1. Project Channel Reaches

A. **Future Channel Extension for LPP (Sta. -300+00 to Sta. -350+00).** Should the LPP be selected, this proposed future reach will extend from the present offshore terminus out further into the Gulf of Mexico until the 57-foot contour is encountered.

B. **Future Channel Extension for NED (Sta. -300+00 to Sta. -435+00).** Should the NED be selected, this proposed future reach will extend from the present offshore terminus out further into the Gulf of Mexico until the 62-foot contour is encountered.

C. **Outer Bar (Sta. -300+00 to Sta. 0+00).** This offshore channel reach under present authorization extends 30,000 feet out into the Gulf of Mexico from its juncture with the jetty channel. Vessels in the entrance channel are completely exposed to cross-currents and waves from the open Gulf. The proposed plans provide for widening the channel 200 feet and 140 feet for the LPP (55'x600') and NED (60'x540'), respectively.

D. **Jetty Channel (Sta. 0+00 to Sta. 70+00).** This offshore channel reach under present authorization extends 6,346 feet landward from its juncture with the entrance channel. Vessels in the jetty channel are sheltered from cross-currents and waves by the jetties. The proposed plans provide for transition taper after widening the channel 200 feet and 140 feet for the LPP (55'x600') and NED (60'x540'), respectively

E. **Lower Turning Basin (Sta.71+52 to Sta.78+52).** This turning basin reach under present authorization is 750 feet in diameter and is located at the intersection of the GIWW and Freeport Harbor channel adjacent the future LNG facility. The proposed plans provide for no change other than deepening as required per LPP or NED.

F. **Channel to New Brazosport Turning Basin (Sta.78+52 to Sta. 101+00).** This reach under present authorization varies in width 400 feet and extends west from the intersection of the GIWW and Freeport Harbor channel adjacent the future LNG facility. The proposed plans provide for no change other than deepening as required per LPP or NED

G. **New Brazosport Turning Basin (Sta. 101+00 to Sta. 115+00).** This turning basin reach under present authorization is 1,000 feet in diameter and is located at the terminus of seaway terminal adjacent the GIWW. The proposed plans provide for increasing the footprint to a 1,350-foot diameter and associated deepening as required per LPP or NED.

H. **Channel from New Brazosport Turning Basin (Sta. 115+00 to 132+66).** This reach under present authorization varies in width 250-400 feet and extends west from the existing Brazosport Turning Basin parallel to seaway terminal. The proposed plans provide for no change other than deepening as required per LPP or NED.

I. **Channel Upper Reach from Station (132+66 to Sta. 174+00).** This reach under present authorization varies in width 275-550 feet and extends west from the existing Brazosport Turning Basin parallel seaway terminal. The proposed plans provide for no change other than deepening as required per LPP or NED.

J. **Upper Turning Basin (Sta. 174+00 to 184+20).** This turning basin reach under present authorization is 1,200 feet in diameter and is the existing project terminus offset the Brazos Harbor channel. The proposed plans provide for no change other than deepening as required per LPP or NED.

K. **Stauffer Channel, Lower Reach (184+20 to 222+00).** This lower existing 200-foot-wide reach adjacent Dow Chemical under present authorization is de-authorized. The proposed plans provide for re-authorizing and improving the channel reach to 40 by 300 feet for the NED or 50 by 300 feet for the LPP.

L. **Stauffer Channel, Upper Reach (222+00 to 260+00).** This upper existing reach, which includes a 500-foot-wide turning basin, is currently de-authorized. The proposed plans provide for re-authorizing and improving the channel reach to 30 by 200 feet to include the 500- by 500-foot-diameter turning basin for both the NED and LPP.

The feasibility study resulted in choosing the LPP. The above reaches were then placed into separate contracts that equate to an approximate 1-year duration. Those separate contracts were then studied within the CSRA framework. Note that the District's choice to establish acquisition strategy and contract duration at this stage greatly diminished certain risks. Those contracts, as compared to the above table and under risk study, are:

- Contract 1: Future Channel Extension and One-Half Outer Bar Channel
- Contract 2: One-Half Outer Bar Channel and Jetty Channel
- Contract 3: Lower Turning Basin
- Contract 4: Real Estate PA8
- Contract 5: Channel to Brazosport through Turning Basin
- Contract 6: Channel to Upper Turning Basin through Upper Turning Basin
- Contract 7: Stauffer Channel - Lower and Upper Reach
- Contract 8: Environmental Mitigation

3.2 USACE Risk Analysis Process

The risk analysis process reflected within the risk analysis report uses probabilistic CSRA methods within the framework of the Crystal Ball software. The risk analysis results are intended to serve several functions, one being the establishment of reasonable contingencies reflective of an 80 percent confidence level to successfully accomplish the project work within that established contingency amount. Furthermore, the scope of the report includes the identification and communication of important steps, logic, key assumptions, limitations, and decisions to help ensure that risk analysis results can be appropriately interpreted.

Risk analysis results are also intended to provide project leadership with contingency information for scheduling, budgeting, and project control purposes, as well as provide tools to support decision making and risk management as the project progresses through planning and implementation. To fully recognize its benefits, CSRA should be considered as an ongoing process conducted concurrent to, and iteratively with, other important project processes such as scope and execution plan development, resource planning, procurement planning, cost estimating, budgeting, and scheduling.

In addition to broadly defined risk analysis standards and recommended practices, the risk analysis is performed to meet the requirements and recommendations of the following documents and sources:

- CSRA process guidance prepared by the USACE Cost Engineering TCX.
- Memorandum from Major General Don T. Riley (U.S. Army Director of Civil Works), dated July 3, 2007.
- Engineering and Construction Bulletin issued by James C. Dalton, P.E. (Chief, Engineering and Construction, Directorate of Civil Works), dated September 10, 2007.
- ER 1110-2-1150, dated August 31, 1999.
- ER 1110-2-1302, dated September 15, 2008.
- Engineering Technical Letter 1110-2-573, dated September 30, 2008.

4. METHODOLOGY/PROCESS

The risk analysis process for this study is intended to determine the probability of various cost outcomes and quantify the required contingency needed in the cost estimate to achieve any desired level of cost confidence. A parallel process is also used to determine the probability of various project schedule duration outcomes and quantify the required schedule contingency (i.e., float) needed in the schedule to achieve any desired level of schedule confidence.

In simple terms, contingency is an amount added to an estimate (cost or schedule) to allow for items, conditions, or events for which the occurrence or impact is uncertain and that experience suggests will likely result in additional costs being incurred or additional time being required. The amount of contingency included in project control plans depends, at least in part, on the project leadership's willingness to accept risk of project overruns. The less risk that project leadership is willing to accept the more contingency should be applied in the project control plans. The risk of overrun is expressed in a probabilistic context using confidence levels.

The USACE Cost Engineering TCX for Civil Works guidance for CSRA generally focuses on the 80-percent level of confidence (P80) for cost contingency calculation. It should be noted that use of P80 as a decision criteria is a risk-adverse approach (whereas the use of P50 would be a risk-neutral approach, and use of levels less than 50 percent would be risk seeking). Thus, a P80 confidence level results in greater contingency as compared to a P50 confidence level.

The risk analysis process uses *Monte Carlo* techniques to determine probabilities and contingency. The *Monte Carlo* techniques are facilitated computationally by a commercially available risk analysis software package (Crystal Ball) that is an add-in to Microsoft Excel. Cost estimates are packaged into an Excel format and used directly for cost risk analysis purposes.

Since the dredging estimates for this project were developed within the USACE Cost Engineering Dredge Estimating Program (CEDEP), which is Excel based, the risk analysis used the CEDEP as the risk model basis, incorporating both cost and schedule. Contracts 4 and 8 (Jet Grouting and Environmental Mitigation) costs were transferred into Excel to support the risk analysis.

The primary steps, in functional terms, of the risk analysis process are described in the following subsections. Risk analysis results are provided in section 5.

4.1 Identify and Assess Risk Factors

Identifying the risk factors via the project development team (PDT) are considered a qualitative process that results in establishing a risk register document. The risk register document then serves to support the quantitative study using the Crystal Ball risk software. Risk factors are events and conditions that may influence or drive uncertainty in project performance. They may be inherent characteristics or conditions of the project or external influences, events, or conditions such as weather or economic conditions. Risk factors may have either favorable or unfavorable impacts on project cost and schedule.

The qualitative risks were captured and placed within the risk register format. This format is the basis used for establishing the quantitative risks and developing the Crystal Ball risk model.

Specifically related to this project, it became apparent that the contracts related to dredging carried similar risks (Contracts 1, 2, 3, 5, 6, and 7). For this reason, the dredging contracts utilized the same risk events identified within the risk register to support the risk models and resulting contingencies. Separate risk registers were developed for Contract 4 (Jet Grouting) and Contract 8 (Environmental Mitigation).

4.2 Risk Registers

A risk register is a tool commonly used in project planning and risk analysis. The risk register reflects the results of risk factor identification and assessment, risk factor quantification, and contingency analysis. It is important to note that a risk register can be an effective tool for managing identified risks throughout the project life cycle. As such, it is generally recommended that risk registers be updated as the designs, cost estimates, and schedule are further refined, especially on large projects with extended schedules. Recommended uses of the risk register going forward include:

- Documenting risk mitigation strategies being pursued in response to the identified risks and their assessment in terms of probability and impact.
- Providing project sponsors, stakeholders, and leadership/management with a documented framework from which risk status can be reported in the context of

project controls.

- Communicating risk management issues.
- Providing a mechanism for eliciting risk analysis feedback and project control input.
- Identifying risk transfer, elimination, or mitigation actions required for implementation of risk management plans.

The summary risk registers in tables 2 and 3 make distinction between two primary categories: dredging and environmental mitigation. Once established, the risk registers serve as the risk analysis model per contract. In the cases studied, the schedule analysis was incorporated into the cost analysis as another risk event.

Table 2. Dredging Risk Register

Risk No.	Risk/Opportunity Event	Discussion and Concerns	Likelihood*	Impact*	Risk Level*	Measurement / Adjustments	Risk Applied to
1	Bidding Climate	Corps studies have resulted in an expected dredge shortage as compared to the many anticipated projects in the Gulf region. Less competition is likely, resulting in longer mobilizations, higher bids. Acquisition planning may help alleviate some of this concern.	VERY LIKELY	SIGNIFICANT	HIGH	Limited Bid Competition impacting Mobilization distance and contractor markups.	Contractor
2	Dredge Material	Inadequate Geotechnical data of the dredged material may result in a more difficult material, such as stiff clays, that would impact productivity.	LIKELY	MARGINAL	MODERATE	Productivity - Duration	Production
3	Dredged Quantity (prism)	Dredging commonly results in changed quantities resulting from inadequate underwater surveys. There is potential that the dredging material prism could change.	UNLIKELY	SIGNIFICANT	MODERATE	Volume - CY	Production
4	Scope Changes	As the designs are further developed, there is potential that the scope could change.	UNLIKELY	SIGNIFICANT	MODERATE	Volume - CY	Dredge quantity
5	Weather	Severe weather in the Gulf region can cause delays and possible remobilizations. To impact dredging, weather would have to be very severe.	UNLIKELY	SIGNIFICANT	MODERATE	Productivity - Duration	Equipment

Dredging Risk Register (Continued)

Risk No.	Risk/Opportunity Event	Discussion and Concerns	Likelihood*	Impact*	Risk Level*	Measurement / Adjustments	Risk Applied to
6	Schedule Constraints	Contract and environmental schedule constraints can cause delays, force acceleration, require larger dredges that may be unavailable due to competing needs. The greater schedule concern would be funding availability which studied under a different risk.	UNLIKELY	MARGINAL	LOW	Duration	Equipment
7	Labor Availability/Pricing	Gulf region labor is fairly low when compared to national rates. Slower economy should keep the rates reasonable with little impact. Travel and per diem could be an issue.	UNLIKELY	SIGNIFICANT	MODERATE	Hourly Wage Rates	Labor
8	Equipment Availability/Pricing	Corps studies suggest a possible dredge shortage, but this concern has lessened 6 years post-Katrina in the Gulf region. A shortage and lost competition could still impact bids.	UNLIKELY	SIGNIFICANT	MODERATE	Equipment Rates	Contractor
9	Fuel Prices	Fuel price fluctuations continue. Dredge operations are significantly impacted by fuel usage and cost. Current estimate is based on current fuel prices.	VERY LIKELY	SIGNIFICANT	HIGH	Fuel $/Gal	Fuel
10	Potential savings due to innovation, streamlining, and gains in efficiency	There seems to be little potential for efficiency gains with the dredging projects. "It is what it is."	VERY UNLIKELY	NEGLIGIBLE	LOW	Volume - CY	N/A
11	Inflation Increases	Inflationary costs could impact project costs in the long term. Volatile fuel pricing on a dredge project could exceed standard Office of Management and Budget (OMB) inflation rates.	LIKELY	MARGINAL	MODERATE	Escalation comparisons	Contract

Table 3. Environmental Mitigation Risk Register

Risk No.	Risk/Opportunity Event	Discussion and Concerns	Likelihood*	Impact*	Risk Level*	Measurement / Adjustments	Risk Applied to
1	Bidding Climate	There is some concern that bidding climate may result in less competitive bids. Current market in the area seems fairly robust and is supported by large industry in the vicinity.	UNLIKELY	SIGNIFICANT	MODERATE	+or- 20%	Contract
2	Quotes - Estimate Confidence	Mitigation estimate totals approximately $100,000 which is a very small part of the project. Of the $100,000, 25% is supported by a quote. The remaining costs are structured as unit prices similar to historical values. Estimate confidence is more related to quantity of acres involved.	LIKELY	MARGINAL	MODERATE	Scope Changes	Contract
3	Scope Changes	Feasibility level design, resulting in potential that quantities could change. Cost to overall project is minimal (less than one %).	LIKELY	MARGINAL	MODERATE	Scope Changes	Contract
4	Weather	Severe weather in the Gulf region can cause delays and possible remobilizations. This impacts productivity. Weather impacts of severity would be somewhat unlikely for plantings.	UNLIKELY	MARGINAL	LOW	Unstudied	Quotes
5	Labor Availability/Pricing	Gulf region labor is fairly low when compared to national rates. Slower economy should keep the rates reasonable with little impact. Travel and per diem could be an issue.	UNLIKELY	MARGINAL	LOW	Unstudied	N/A
6	Fuel Prices	Fuel price fluctuations continue. Fuel more greatly impacts dredging costs. This part of the work is not dredging.	UNLIKELY	MARGINAL	LOW	Unstudied	N/A
7	Savings Opportunities	There seems to be little potential for efficiency gains with the jet grouting. It must be done.	UNLIKELY	NEGLIGIBLE	LOW	Unstudied	N/A
8	Inflation Increases	Inflationary costs could impact project costs in the long term. Volatile fuel pricing on a dredge project could exceed standard OMB inflation rates. Current estimate fuel pricing is considered conservative.	LIKELY	MARGINAL	MODERATE	Applied in CSRA model	Contract

4.3 Quantify Risk Factor Impacts

The quantitative impacts of risk factors on project plans are analyzed using a combination of professional judgment, empirical data, and analytical techniques. Risk factor impacts are quantified using probability distributions (density functions), because risk factors are entered into the Crystal Ball software in the form of probability density functions.

Similar to the identification and assessment process, risk factor quantification involves multiple project team disciplines and functions. However, the quantification process relies more extensively on collaboration between cost engineering, designers, and risk analysis team members with lesser inputs from other functions and disciplines.

The following is an example of the PDT quantifying risk factor impacts by using an iterative, consensus-building approach to estimate the elements of each risk factor:

- Maximum possible value for the risk factor.
- Minimum possible value for the risk factor.
- Most likely value (the statistical mode), if applicable.
- Nature of the probability density function used to approximate risk factor uncertainty.
- Mathematical correlations between risk factors.
- Affected cost estimate and schedule elements.

In this study, the risk discussions focused on the dredging contracts since they were similar in nature of risks, as well as comprised the bulk of the project costs. Note that the risk register records the PDT's risk concerns, discussions related to those concerns, and potential impacts to the current cost and schedule estimates. The concerns and discussions are meant to support the team's decisions related to event likelihood, impact, and the resulting risk levels for each risk event.

For the six dredge contracts, the estimates were developed using USACE's CEDEP, which is Excel based and can also be used to support the Crystal Ball model. The CEDEP model allowed risk study at the detailed estimate level by incorporating variances for direct and indirect costs that support the risk register concerns. The study went even further, considering items such contractor markups, mobilization, quantities, and productivities. Within that same CEDEP, schedule variance is also included since it relates to the productivity factors found within CEDEP.

4.4 Analyze Cost Estimate and Schedule Contingency

Contingency is analyzed using the Crystal Ball software (an add-in to the Microsoft Excel format of the cost estimate and schedule). *Monte Carlo* simulations are performed by applying the risk factors (quantified as probability density functions) to the appropriate estimated cost and schedule elements identified by the PDT. Contingencies are calculated by applying only the moderate and high level risks identified for each option (i.e., low-level risks are typically not considered but remain within the risk register to serve historical purposes as well as support follow-on risk studies as the project and risks evolve).

For the cost estimate, the contingency is calculated as the difference between the P80 cost forecast and the base cost estimate. Each option-specific contingency is then allocated on a civil works feature level based on the dollar-weighted relative risk of each feature as quantified by *Monte Carlo* simulation. Standard deviation is used as the feature-specific measure of risk for contingency allocation purposes. This approach results in a relatively larger portion of all the project feature cost contingency being allocated to features with relatively higher estimated cost uncertainty.

For schedule contingency within this analysis, noting that the contracts were separated into an approximate 1-year construction duration, the schedule risk of escalation was applied within the cost risk model.

5. RISK ANALYSIS RESULTS

5.1 Contingency Results at 80 Percent Confidence

The Cost Engineering TCX recommends risk analyses output reflect the P80 confidence level in successfully completing the project. The following table reflects those results for the eight specific contracts. It is these contingencies that are reflected within the Total Project Cost Summary.

Table 4. Contract Contingency Results - 80 Percent Confidence

Contract No.	Contract Description/Title	Type of Work	Contingency
Contract 1	Future Channel Extension and One-Half Outer Bar Channel	Dredging	24%
Contract 2	One-Half Outer Bar Channel and Jetty Channel	Dredging	24%
Contract 3	Lower Turning Basin	Dredging	24%
Contract 4	Real Estate for PA8		24%
Contract 5	Channel to Brazosport through Turning Basin	Dredging	24%
Contract 6	Channel to Upper Turning Basin through Upper Turning Basin	Dredging	24%
Contract 7	Stauffer Channel - Lower and Upper Reach	Dredging	24%
Contract 8	Environmental Mitigation	Mitigation	24%

Note: Contingency % reflects an 80% confidence level. While the Mitigation contingency was less, the District chose 24% to remain consistent with the dredging contingency.

5.2 Model Sensitivity Analysis and Output

The sensitivity analysis output indicates the risk events carrying the greatest potential variance in cost and schedule that also result in the greatest risks. For this report, the sensitivity results are presented for a sample of the dredging projects and environmental mitigation.

5.2.1 Dredging Sensitivity

The four most common risk concerns related to dredging, carrying the greater risks noted in the figure below were concern for:

- Fuel price fluctuations and volatility.
- Contractor overhead assumptions and bidding climate/competition.
- Uncertain dredge material classifications, which can impact productivity assumptions.
- Dredging prism, which defines the quantities dredged.

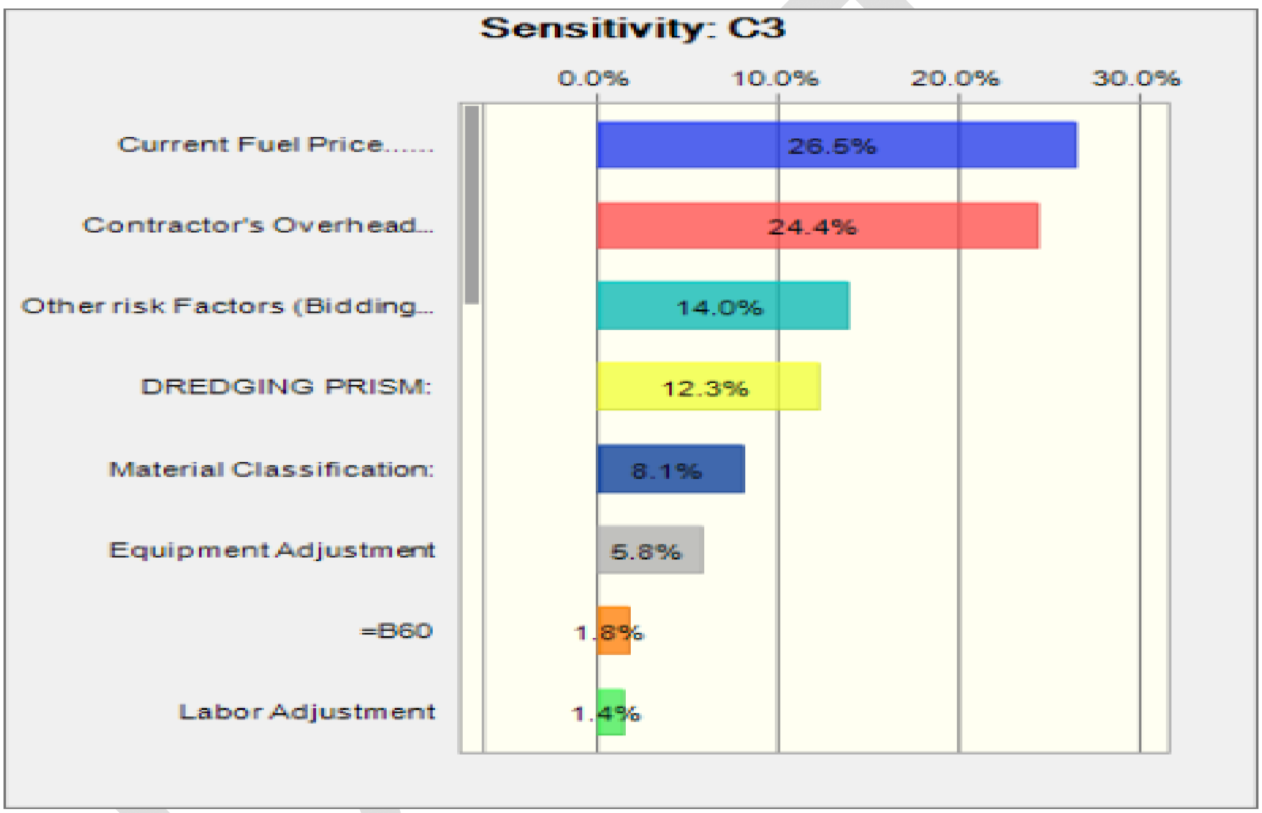

Figure 1. Dredging Sensitivity

Fuel Price Fluctuations: Within the past decade, fuel prices have fluctuated dramatically, but continue to creep higher as each price rise settles. While the previous risk of Inflation would seem to capture this issue, the two were studied separately. Fuel pricing is an element of the estimate, while inflation and funding are elements of the program. Fuel pricing fluctuations are currently unavoidable; however, contract solicitations may benefit from timely award during low fuel season.

Contractor Overhead and Bidding Climate/Competition: USACE studies of future dredging needs have indicated that there is a potential shortage of dredges to support the dredging programs in the Gulf regions. To further complicate, differences in assumed estimate overheads can vary between small and large businesses within that competition. The risk may be mitigated depending on acquisition strategy, dredging season as related to severe weather, fuel costs, any wildlife implications, and contract duration.

Uncertain Dredge Material Classifications: As geotechnical investigations continue during PED phase, better understanding of the dredged materials will be obtained. Until then, limited geotechnical data results in a less confident estimated productivity of that dredged material.

Dredging Prism: Dredging Prism equates to quantities dredged. As better survey information is obtained and designs mature, this risk is reduced; however, until that occurs, confidence and quantity variance remains a concern. The other main concern is related to the construction activities in the way of quantity impacts and modifications, resulting in further quantity variance.

5.2.2 Environmental Mitigation

Studies indicate that the environmental mitigation risks are less than the dredging risks and resulted in a lower contingency. With the minimal overall project cost to the project, the PDT chose to apply the same 24% contingency as calculated in the dredging contracts. Though small, the four most common risk concerns related to the environmental mitigation, carrying the greater risks noted in the figure below were concerned for:

- Bidding climate and competition.
- Inflation rates in the local area potentially exceeding the annual OMB rates.
- Potential for scope changes before and after construction contract award.
- Work in the out years subject to cost variances not captured within the estimate or the risk analysis.

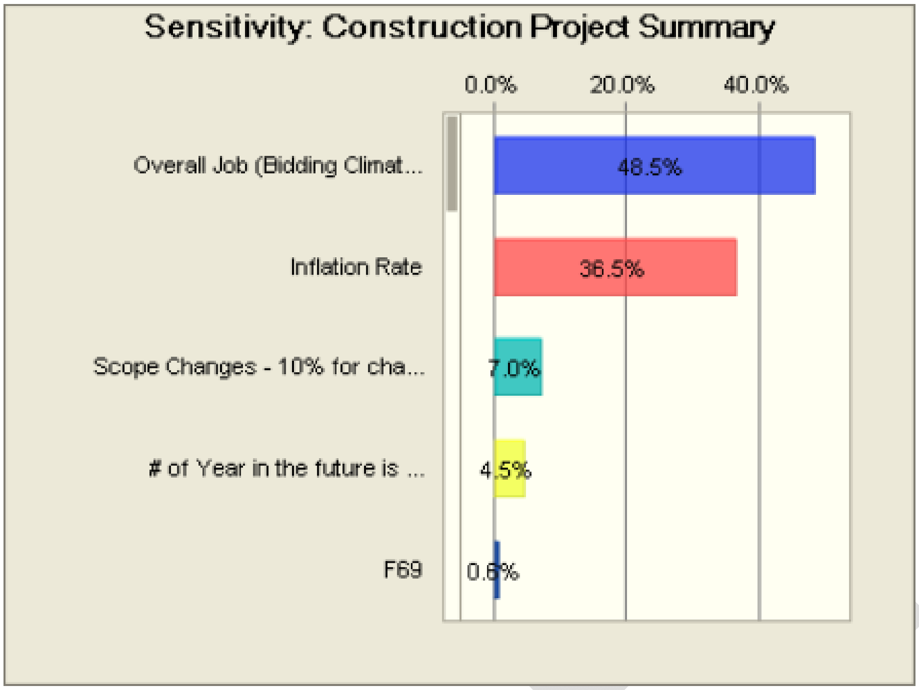

Figure 2. Environmental Mitigation Sensitivity

Bidding Climate: Bidding climate is a concern related to the current market conditions but also the risks carried within the quality of the acquisition strategy and contract package. Bidding climate can also be a reflection of the contract acquisition strategy such as small business, sole source procurement, etc. These methods commonly increase construction contract costs in the form of less competition, higher contractor markups, etc.

Inflation: There is a concern that over time, while waiting for Federal funding, the OMB escalation rates may not fully adjust for the local market. In the case of jet grouting, as compared to dredging activities, this risk is less. Yet the risk remains and is a common risk when the program is accomplished over a lengthy period of time.

Scope Changes: Generally speaking, feasibility designs typically lack adequate geotechnical information that can impact the quantities greatly. As better survey information is obtained and designs mature, this risk is reduced; however, until that occurs, confidence and quantity variance remains a concern. The other main concern is related to the construction activities in the way of quantity impacts and modifications, resulting in further quantity variance.

Work in the Out Years: The environmental mitigation work is scheduled in the out years. Over time, there is greater risk related to scope changes and unit cost variances. This item addresses the potential for unit cost variances.

**** TOTAL PROJECT COST SUMMARY ****

PROJECT: NED - Freeport Harbor, Deepening and Selective Widening
LOCATION: Freeport, Texas

DISTRICT: Galveston District PREPARED: 3/30/2012
POC: CHIEF, COST ENGINEERING, Willie Joe Honza

This Estimate reflects the scope and schedule in report; Project Feasibility Report

Program Year (Budget EC): 2014
Effective Price Level Date: 1 OCT 13

		ESTIMATED COST				PROJECT FIRST COST				TOTAL PROJECT COST (FULLY FUNDED)				
										Spent Thru:				
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	1-Oct-11 ($K)		COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*K*	*L*	*M*	*N*	*O*
12	NAVIGATION PORTS & HARBORS		-			-								
12	Non- Federal	$46,112	$11,067	24%	$57,179	3.0%	$47,482	$11,396	**$58,878**			$49,959	$11,990	$61,949
12	Federal	$219,834	$52,760	24%	$272,594	3.0%	$226,366	$54,328	**$280,694**			$238,040	$57,130	$295,169
06	FISH & WILDLIFE FACILITIES	$130	$31	24%	$161	3.0%	$134	$32	**$166**			$145	$35	$180
	CONSTRUCTION ESTIMATE TOTALS:	$266,076	$63,858		**$329,934**	3.0%	$273,982	$65,756	**$339,737**			$288,143	$69,154	$357,298
01	LANDS AND DAMAGES	$1,491	$162	11%	$1,653	3.0%	$1,535	$167	**$1,702**			$1,605	$175	$1,780
30	PROJECT EXPENDITURES													
	Non-Federal Cost									4,050				$4,050
	Federal Cost									4,050				$4,050
30	PLANNING, ENGINEERING & DESIGN	$29,486	$7,094	24%	$36,580	4.1%	$30,689	$7,384	**$38,073**			$32,786	$7,891	$40,677
31	CONSTRUCTION MANAGEMENT	$18,636	$4,473	24%	$23,109	4.1%	$19,396	$4,655	**$24,051**			$21,608	$5,186	$26,793
	PROJECT COST TOTALS:	$315,689	$75,587	24%	**$391,276**	3.1%	$325,602	$77,961	**$403,564**	8,100		$344,143	$82,406	$434,648

CHIEF, COST ENGINEERING, Willie Joe Honza

PROJECT MANAGER, Sharon Tirpak

CHIEF, REAL ESTATE, Orlando Rosa

CHIEF, PLANNING, Dolan Dunn

CHIEF, ENGINEERING, Robert Howell

CHIEF, OPERATIONS, Joe Hrametz

CHIEF, CONSTRUCTION, Don Carelock

CHIEF, CONTRACTING, John Eugino

CHIEF, PM-J, Valerie Miller

CHIEF, DPM, Pete Perez

ESTIMATED FEDERAL COST:	**$366,869**
ESTIMATED NON-FEDERAL COST:	**$67,779**
ESTIMATED TOTAL PROJECT COST:	**$434,648**

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: NED - Freeport Harbor, Deepening and Selective Widening
LOCATION: Freeport, Texas
This Estimate reflects the scope and schedule in report; Project Feasibility Report

DISTRICT: Galveston District PREPARED: 3/30/2012
POC: CHIEF, COST ENGINEERING, Willie Joe Honza

Estimate Prepared: 30-Mar-12
Effective Price Level: 1-Oct-11

Program Year (Budget EC): 2014
Effective Price Level Date: 1 OCT 13

FULLY FUNDED PROJECT ESTIMATE

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	RISK BASED CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	Cont #1 - Future Ch Extension & Half of Outer Bar Ch													
12	NAVIGATION PORTS & HARBORS													
12	Hopper Dredge	$76,232	$18,296	24%	$94,528	3.0%	$78,497	$18,839	$97,336	2016Q2	4.0%	$81,655	$19,597	$101,253
12	Navigation Aids	$90	$22	24%	$112	3.0%	$93	$22	$115	2016Q2	4.0%	$96	$23	$120
	CONSTRUCTION ESTIMATE TOTALS:	$76,322	$18,317	24%	**$94,639**		$78,590	$18,862	$97,451			$81,752	$19,620	$101,372
01	LANDS AND DAMAGES													
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	$763	$183	24%	$946	4.1%	$794	$191	$985	2014Q4	2.8%	$817	$196	$1,013
1.0%	Planning & Environmental Compliance	$763	$183	24%	$946	4.1%	$794	$191	$985	2014Q4	2.8%	$817	$196	$1,013
5.0%	Engineering & Design	$3,816	$916	24%	$4,732	4.1%	$3,972	$953	$4,925	2014Q4	2.8%	$4,084	$980	$5,064
1.0%	Engineering Tech Review ITR & VE	$763	$183	24%	$946	4.1%	$794	$191	$985	2014Q4	2.8%	$817	$196	$1,013
1.0%	Contracting & Reprographics	$763	$183	24%	$946	4.1%	$794	$191	$985	2014Q4	2.8%	$817	$196	$1,013
	Real Estate In-House Labor			26%										
2.0%	Engineering During Construction	$1,526	$366	24%	$1,892	4.1%	$1,588	$381	$1,969	2016Q2	8.9%	$1,730	$415	$2,145
				24%										
	Project Operations			24%										
31	CONSTRUCTION MANAGEMENT													
6.0%	Construction Management	$4,579	$1,099	24%	$5,678	4.1%	$4,766	$1,144	$5,910	2016Q2	8.9%	$5,190	$1,246	$6,436
	Project Operation:			24%										
1.0%	Project Management	$763	$183	24%	$946	4.1%	$794	$191	$985	2016Q2	8.9%	$865	$208	$1,072
	CONTRACT COST TOTALS:	$90,058	$21,614		**$111,672**		$92,886	$22,293	$115,179			$96,887	$23,253	**$120,140**

****** TOTAL PROJECT COST SUMMARY ******

****** CONTRACT COST SUMMARY ******

PROJECT: NED - Freeport Harbor, Deepening and Selective Widening
LOCATION: Freeport, Texas
This Estimate reflects the scope and schedule in report; Project Feasibility Report

DISTRICT: Galveston District PREPARED: 3/30/2012
POC: CHIEF, COST ENGINEERING, Willie Joe Honza

Estimate Prepared: 30-Mar-12
Effective Price Level: 1-Oct-11

Program Year (Budget EC): 2014
Effective Price Level Date: 1 OCT 13

FULLY FUNDED PROJECT ESTIMATE

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	Contract #2 - Half of Outer Bar Ch & Jetty Ch													
12	NAVIGATION PORTS & HARBORS													
12	Hopper Dredge	$89,099	$21,384	24%	$110,483	3.0%	$91,746	$22,019	$113,765	2017Q2	5.9%	$97,155	$23,317	$120,473
12	Navigation Aids	$1,000	$240	24%	$1,240	3.0%	$1,030	$247	$1,277	2017Q2	5.9%	$1,090	$262	$1,352
	CONSTRUCTION ESTIMATE TOTALS:	$90,099	$21,624	24%	**$111,723**		$92,776	$22,266	$115,042			$98,246	$23,579	$121,825
01	LANDS AND DAMAGES													
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	$901	$216	24%	$1,117	4.1%	$938	$225	$1,163	2015Q2	4.8%	$983	$236	$1,219
1.0%	Planning & Environmental Compliance	$901	$216	24%	$1,117	4.1%	$938	$225	$1,163	2015Q2	4.8%	$983	$236	$1,219
5.0%	Engineering & Design	$4,505	$1,081	24%	$5,586	4.1%	$4,689	$1,125	$5,814	2015Q2	4.8%	$4,915	$1,180	$6,095
1.0%	Engineering Tech Review ITR & VE	$901	$216	24%	$1,117	4.1%	$938	$225	$1,163	2015Q2	4.8%	$983	$236	$1,219
1.0%	Contracting & Reprographics	$901	$216	24%	$1,117	4.1%	$938	$225	$1,163	2015Q2	4.8%	$983	$236	$1,219
	Real Estate In-House Labor			26%										
2.0%	Engineering During Construction	$1,802	$432	24%	$2,234	4.1%	$1,876	$450	$2,326	2017Q2	13.0%	$2,119	$509	$2,628
				24%										
	Project Operations			24%										
31	CONSTRUCTION MANAGEMENT													
6.0%	Construction Management	$5,406	$1,297	24%	$6,703	4.1%	$5,627	$1,350	$6,977	2017Q2	13.0%	$6,358	$1,526	$7,884
	Project Operation:			24%										
1.0%	Project Management	$901	$216	24%	$1,117	4.1%	$938	$225	$1,163	2017Q2	13.0%	$1,060	$254	$1,314
	CONTRACT COST TOTALS:	$106,317	$25,516		**$131,833**		$109,656	$26,317	$135,973			$116,630	$27,991	**$144,621**

****** TOTAL PROJECT COST SUMMARY ******

PROJECT: NED - Freeport Harbor, Deepening and Selective Widening
LOCATION: Freeport, Texas
This Estimate reflects the scope and schedule in report; Project Feasibility Report

DISTRICT: Galveston District PREPARED: 3/30/2012
POC: CHIEF, COST ENGINEERING, Willie Joe Honza

	Estimate Prepared:	30-Mar-12				Program Year (Budget EC):			2014					
	Effective Price Level:	1-Oct-11				Effective Price Level Date:			1 OCT 13	FULLY FUNDED PROJECT ESTIMATE				
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	Contract #3 -Lower TB													
12	NAVIGATION PORTS & HARBORS													
12	Non-Fed Costs	$9,488	$2,277	24%	$11,765	3.0%	$9,770	$2,345	$12,115	2015Q3	2.6%	$10,028	$2,407	$12,435
12	Federal Cost	$2,992	$718	24%	$3,710	3.0%	$3,081	$739	$3,820	2015Q3	2.6%	$3,162	$759	$3,921
	CONSTRUCTION ESTIMATE TOTALS:	$12,480	$2,995	24%	**$15,475**		$12,851	$3,084	$15,935			$13,191	$3,166	$16,356
01	LANDS AND DAMAGES	$63	$7	11%	$70	3.0%	$65	$7	$72	2015Q2	2.2%	$66	$7	$74
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	$125	$30	24%	$155	4.1%	$130	$31	$161	2015Q2	4.8%	$136	$33	$169
1.0%	Planning & Environmental Compliance	$125	$30	24%	$155	4.1%	$130	$31	$161	2015Q2	4.8%	$136	$33	$169
5.0%	Engineering & Design	$624	$150	24%	$774	4.1%	$649	$156	$805	2015Q2	4.8%	$681	$163	$844
1.0%	Engineering Tech Review ITR & VE	$125	$30	24%	$155	4.1%	$130	$31	$161	2015Q2	4.8%	$136	$33	$169
1.0%	Contracting & Reprographics	$125	$30	24%	$155	4.1%	$130	$31	$161	2015Q2	4.8%	$136	$33	$169
2.0%	Engineering During Construction	$250	$60	24%	$310	4.1%	$260	$62	$323	2015Q3	5.8%	$275	$66	$342
	Real Estate In-House Labor	$10	$2	20%	$12	4.1%	$10	$2	$12	2015Q3	5.8%	$11	$2	$13
	Project Operations			24%										
31	CONSTRUCTION MANAGEMENT													
6.0%	Construction Management	$749	$180	24%	$929	4.1%	$780	$187	$967	2015Q3	5.8%	$825	$198	$1,023
	Project Operation:			24%										
1.0%	Project Management	$125	$30	24%	$155	4.1%	$130	$31	$161	2015Q3	5.8%	$138	$33	$171
	CONTRACT COST TOTALS:	$14,801	$3,544		**$18,345**		$15,266	$3,655	$18,921			$15,733	$3,767	**$19,499**

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: NED - Freeport Harbor, Deepening and Selective Widening
LOCATION: Freeport, Texas
This Estimate reflects the scope and schedule in report; Project Feasibility Report

DISTRICT: Galveston District PREPARED: 3/30/2012
POC: CHIEF, COST ENGINEERING, Willie Joe Honza

Estimate Prepared: 30-Mar-12
Effective Price Level: 1-Oct-11

Program Year (Budget EC): 2014
Effective Price Level Date: 1 OCT 13

FULLY FUNDED PROJECT ESTIMATE

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	Contract #4 - Real Estate for PA 8													
11	LEVEES & FLOODWALLS													
04	DAMS													
05	LOCKS													
06	FISH & WILDLIFE FACILITIES													
07	POWER PLANT													
	CONSTRUCTION ESTIMATE TOTALS:													
01	LANDS AND DAMAGES	$480	$48	10%	$528	3.0%	$494	$49	$544	2015Q1	1.7%	$503	$50	$553
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management													
1.0%	Planning & Environmental Compliance													
5.0%	Engineering & Design													
1.0%	Engineering Tech Review ITR & VE													
1.0%	Contracting & Reprographics													
	Real Estate In-House Labor	$10	$2	20%	$12	4.1%	$10	$2	$12	2015Q1	3.8%	$11	$2	$13
2.0%	Engineering During Construction													
	Project Operations													
31	CONSTRUCTION MANAGEMENT													
6.0%	Construction Management													
	Project Operation:													
1.0%	Project Management													
	CONTRACT COST TOTALS:	$490	$50		**$540**		$505	$52	$556			$514	$52	**$566**

****** TOTAL PROJECT COST SUMMARY ******

****** CONTRACT COST SUMMARY ******

PROJECT: NED - Freeport Harbor, Deepening and Selective Widening
LOCATION: Freeport, Texas
This Estimate reflects the scope and schedule in report; Project Feasibility Report

DISTRICT: Galveston District PREPARED: 3/30/2012
POC: CHIEF, COST ENGINEERING, Willie Joe Honza

		Estimate Prepared: 30-Mar-12				Program Year (Budget EC): 2014				FULLY FUNDED PROJECT ESTIMATE				
		Effective Price Level: 1-Oct-11				Effective Price Level Date: 1 OCT 13								
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	Contract #5 - Dredge Ch to BRZPT through BRZPT TB													
12	NAVIGATION PORTS & HARBORS													
12	Non-Fed Costs	$16,428	$3,943	24%	$20,371	3.0%	$16,916	$4,060	$20,976	2016Q2	4.0%	$17,597	$4,223	$21,820
12	Federal Cost	$29,201	$7,008	24%	$36,209	3.0%	$30,069	$7,216	$37,285	2016Q2	4.0%	$31,278	$7,507	$38,785
	CONSTRUCTION ESTIMATE TOTALS:	$45,629	$10,951	24%	**$56,580**		$46,985	$11,276	$58,261			$48,875	$11,730	$60,605
01	LANDS AND DAMAGES	$28	$3	11%	$31	3.0%	$29	$3	$32	2015Q2	2.2%	$29	$3	$33
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	$456	$109	24%	$565	4.1%	$475	$114	$589	2015Q2	4.8%	$497	$119	$617
1.0%	Planning & Environmental Compliance	$456	$109	24%	$565	4.1%	$475	$114	$589	2015Q2	4.8%	$497	$119	$617
5.0%	Engineering & Design	$2,281	$547	24%	$2,828	4.1%	$2,374	$570	$2,944	2015Q2	4.8%	$2,489	$597	$3,086
1.0%	Engineering Tech Review ITR & VE	$456	$109	24%	$565	4.1%	$475	$114	$589	2015Q2	4.8%	$497	$119	$617
1.0%	Contracting & Reprographics	$456	$109	24%	$565	4.1%	$475	$114	$589	2015Q2	4.8%	$497	$119	$617
	Real Estate In-House Labor	$11	$2	18%	$13	4.1%	$11	$2	$14	2015Q2	4.8%	$12	$2	$14
2.0%	Engineering During Construction	$913	$219	24%	$1,132	4.1%	$950	$228	$1,178	2016Q2	8.9%	$1,035	$248	$1,283
	Project Operations													
31	CONSTRUCTION MANAGEMENT													
6.0%	Construction Management	$2,738	$657	24%	$3,395	4.1%	$2,850	$684	$3,534	2016Q2	8.9%	$3,104	$745	$3,848
	Project Operation:			24%										
1.0%	Project Management	$456	$109	24%	$565	4.1%	$475	$114	$589	2016Q2	8.9%	$517	$124	$641
	CONTRACT COST TOTALS:	$53,880	$12,927		**$66,807**		$55,572	$13,333	$68,905			$58,051	$13,928	**$71,978**

****** TOTAL PROJECT COST SUMMARY ******

PROJECT: NED - Freeport Harbor, Deepening and Selective Widening
LOCATION: Freeport, Texas
This Estimate reflects the scope and schedule in report; Project Feasibility Report

DISTRICT: Galveston District
POC: CHIEF, COST ENGINEERING, Willie Joe Honza
PREPARED: 3/30/2012

Estimate Prepared: 30-Mar-12
Effective Price Level: 1-Oct-11

Program Year (Budget EC): 2014
Effective Price Level Date: 1 OCT 13

FULLY FUNDED PROJECT ESTIMATE

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	Contract #6 - Dredge Ch to Upper TB through Upper TB													
12	NAVIGATION PORTS & HARBORS													
12	Non-Fed Costs	$19,104	$4,585	24%	$23,689	3.0%	$19,672	$4,721	$24,393	2018Q1	7.3%	$21,111	$5,067	$26,177
12	Federal Cost	$11,083	$2,660	24%	$13,743	3.0%	$11,412	$2,739	$14,151	2018Q1	7.3%	$12,247	$2,939	$15,187
	CONSTRUCTION ESTIMATE TOTALS:	$30,187	$7,245	24%	**$37,432**		$31,084	$7,460	$38,544			$33,358	$8,006	$41,364
01	LANDS AND DAMAGES	$785	$79	10%	$864	3.0%	$808	$81	$890	2017Q2	5.9%	$856	$86	$942
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	$302	$72	24%	$374	4.1%	$314	$75	$390	2017Q2	13.0%	$355	$85	$440
1.0%	Planning & Environmental Compliance	$302	$72	24%	$374	4.1%	$314	$75	$390	2017Q2	13.0%	$355	$85	$440
5.0%	Engineering & Design	$1,509	$362	24%	$1,871	4.1%	$1,571	$377	$1,948	2017Q2	13.0%	$1,775	$426	$2,201
1.0%	Engineering Tech Review ITR & VE	$302	$72	24%	$374	4.1%	$314	$75	$390	2017Q2	13.0%	$355	$85	$440
1.0%	Contracting & Reprographics	$302	$72	24%	$374	4.1%	$314	$75	$390	2017Q2	13.0%	$355	$85	$440
	Real Estate In-House Labor	$27	$3	11%	$30	4.1%	$28	$3	$31	2017Q2	13.0%	$32	$4	$35
2.0%	Engineering During Construction	$604	$145	24%	$749	4.1%	$629	$151	$780	2018Q1	16.1%	$730	$175	$905
	Project Operations			24%										
31	CONSTRUCTION MANAGEMENT													
6.0%	Construction Management	$1,811	$435	24%	$2,246	4.1%	$1,885	$452	$2,337	2018Q1	16.1%	$2,188	$525	$2,713
	Project Operation:			24%										
1.0%	Project Management	$302	$72	24%	$374	4.1%	$314	$75	$390	2018Q1	16.1%	$365	$88	$452
	CONTRACT COST TOTALS:	$36,433	$8,631		**$45,064**		$37,576	$8,902	$46,478			$40,723	$9,650	**$50,373**

****** TOTAL PROJECT COST SUMMARY ******

****** CONTRACT COST SUMMARY ******

PROJECT: NED - Freeport Harbor, Deepening and Selective Widening
LOCATION: Freeport, Texas
This Estimate reflects the scope and schedule in report; Project Feasibility Report

DISTRICT: Galveston District PREPARED: 3/30/2012
POC: CHIEF, COST ENGINEERING, Willie Joe Honza

Estimate Prepared: 30-Mar-12
Effective Price Level: 1-Oct-11

Program Year (Budget EC): 2014
Effective Price Level Date: 1 OCT 13

FULLY FUNDED PROJECT ESTIMATE

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	Contract #7 -Dredge Stauffer Ch													
12	NAVIGATION PORTS & HARBORS													
12	Non-Fed Costs	$1,092	$262	24%	$1,354	3.0%	$1,124	$270	$1,394	2018Q4	8.8%	$1,223	$294	$1,517
12	Lower Stauffer Ch	$7,612	$1,827	24%	$9,439	3.0%	$7,838	$1,881	$9,719	2018Q4	8.8%	$8,526	$2,046	$10,572
12	Upper Stauffer Ch	$2,525	$606	24%	$3,131	3.0%	$2,600	$624	$3,224	2018Q4	8.8%	$2,828	$679	$3,507
	CONSTRUCTION ESTIMATE TOTALS:	$11,229	$2,695	24%	**$13,924**		$11,563	$2,775	$14,338			$12,577	$3,019	$15,596
01	LANDS AND DAMAGES	$135	$25	19%	$160	3.0%	$139	$26	$165	2018Q3	8.3%	$151	$28	$178
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	$112	$27	24%	$139	4.1%	$117	$28	$145	2018Q3	18.1%	$138	$33	$171
1.0%	Planning & Environmental Compliance	$112	$27	24%	$139	4.1%	$117	$28	$145	2018Q3	18.1%	$138	$33	$171
5.0%	Engineering & Design	$561	$135	24%	$696	4.1%	$584	$140	$724	2018Q3	18.1%	$690	$166	$855
1.0%	Engineering Tech Review ITR & VE	$112	$27	24%	$139	4.1%	$117	$28	$145	2018Q3	18.1%	$138	$33	$171
1.0%	Contracting & Reprographics	$112	$27	24%	$139	4.1%	$117	$28	$145	2018Q3	18.1%	$138	$33	$171
	Real Estate In-House Labor	$115	$50	43%	$165	4.1%	$120	$52	$172	2018Q3	18.1%	$141	$61	$203
2.0%	Engineering During Construction	$225	$54	24%	$279	4.1%	$234	$56	$290	2018Q4	19.1%	$279	$67	$346
	Project Operations			24%										
31	CONSTRUCTION MANAGEMENT													
6.0%	Construction Management	$674	$162	24%	$836	4.1%	$702	$168	$870	2018Q4	19.1%	$836	$201	$1,036
	Project Operation:			24%										
1.0%	Project Management	$112	$27	24%	$139	4.1%	$117	$28	$145	2018Q4	19.1%	$139	$33	$172
	CONTRACT COST TOTALS:	$13,499	$3,255		**$16,754**		$13,924	$3,357	$17,281			$15,363	$3,706	**$19,069**

****** TOTAL PROJECT COST SUMMARY ******

****** CONTRACT COST SUMMARY ******

PROJECT: NED - Freeport Harbor, Deepening and Selective Widening
LOCATION: Freeport, Texas
This Estimate reflects the scope and schedule in report; Project Feasibility Report

DISTRICT: Galveston District PREPARED: 3/30/2012
POC: CHIEF, COST ENGINEERING, Willie Joe Honza

Estimate Prepared: 30-Mar-12
Effective Price Level: 1-Oct-11

Program Year (Budget EC): 2014
Effective Price Level Date: 1 OCT 13

FULLY FUNDED PROJECT ESTIMATE

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B	C	D	E	F	G	H	I	J	P	L	M	N	O
	Contract #8 - PA Mitigation													
06	FISH & WILDLIFE FACILITIES	$130	$31	24%	$ 161	3.0%	$134	$32	$166	2018Q3	8.3%	$145	$35	$180
	CONSTRUCTION ESTIMATE TOTALS:	$130	$31	24%	**161**		$134	$32	$166			$145	$35	$180
01	LANDS AND DAMAGES													
30	PLANNING, ENGINEERING & DESIGN													
5.0%	Project Management	$7	$2	24%	9	4.1%	$7	$2	$9	2018Q1	16.1%	$8	$2	$10
5.0%	Planning & Environmental Compliance	$7	$2	24%	9	4.1%	$7	$2	$9	2018Q1	16.1%	$8	$2	$10
20.0%	Engineering & Design	$26	$6	24%	32	4.1%	$27	$6	$34	2018Q1	16.1%	$31	$8	$39
5.0%	Engineering Tech Review ITR & VE	$7	$2	24%	9	4.1%	$7	$2	$9	2018Q1	16.1%	$8	$2	$10
5.0%	Contracting & Reprographics	$7	$2	24%	9	4.1%	$7	$2	$9	2018Q1	16.1%	$8	$2	$10
5.0%	Engineering During Construction	$7	$2	24%	9	4.1%	$7	$2	$9	2018Q3	18.1%	$9	$2	$11
	Real Estate In-House Labor													
	Project Operations													
31	CONSTRUCTION MANAGEMENT													
10.0%	Construction Management	$13	$3	24%	16	4.1%	$14	$3	$17	2018Q3	18.1%	$16	$4	$20
5.0%	Project Management	$7	$2	24%	9	4.1%	$7	$2	$9	2018Q3	18.1%	$9	$2	$11
	CONTRACT COST TOTALS:	$211	$51		**262**		$218	$52	$271			$243	$58	**$302**

**** TOTAL PROJECT COST SUMMARY ****

PROJECT: LPP - Freeport Harbor, Deepening and Selective Widening
LOCATION: Freeport, Texas

DISTRICT: Galveston District PREPARED: 3/30/2012
POC: CHIEF, COST ENGINEERING, Willie Joe Honza

This Estimate reflects the scope and schedule in report; Project Feasibility Report

							Program Year (Budget EC): 2014							
							Effective Price Level Date: 1 OCT 13			TOTAL PROJECT COST (FULLY FUNDED)				
		ESTIMATED COST				PROJECT FIRST COST				Spent Thru:				
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	**TOTAL ($K)**	31-Mar-12 ($K)		COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*K*	*L*	*M*	*N*	*O*
12	NAVIGATION PORTS & HARBORS		-			-								
12	Non- Federal	$46,112	$11,067	24%	$57,179	3.0%	$47,482	$11,396	**$58,878**			$49,862	$11,967	$61,829
12	Federal	$165,113	$39,627	24%	$204,740	3.0%	$170,019	$40,805	**$210,823**			$178,086	$42,741	$220,826
06	FISH & WILDLIFE FACILITIES	$130	$31	24%	$161	3.0%	$134	$32	**$166**			$145	$35	$180
	CONSTRUCTION ESTIMATE TOTALS:	$211,355	$50,725		**$262,080**	3.0%	$217,635	$52,232	**$269,867**			$228,093	$54,742	$282,835
01	LANDS AND DAMAGES	$1,491	$162	11%	$1,653	3.0%	$1,535	$167	**$1,702**			$1,581	$172	$1,753
30	PROJECT EXPENDITURES													
	Non-Federal Cost									4,050				$4,050
	Federal Cost									4,050				$4,050
30	PLANNING, ENGINEERING & DESIGN	$14,281	$3,445	24%	$17,726	4.1%	$14,864	$3,585	**$18,449**			$15,793	$3,812	$19,606
31	CONSTRUCTION MANAGEMENT	$7,413	$1,779	24%	$9,192	4.1%	$7,715	$1,852	**$9,567**			$8,544	$2,051	$10,595
	PROJECT COST TOTALS:	$234,540	$56,111	24%	**$290,651**	3.1%	$241,749	$57,836	**$299,586**	8,100		$254,011	$60,777	$322,888

______________________ CHIEF, COST ENGINEERING, Willie Joe Honza

______________________ PROJECT MANAGER, Sharon Tirpak

______________________ CHIEF, REAL ESTATE, Orlando Rosa

______________________ CHIEF, PLANNING, Dolan Dunn

______________________ CHIEF, ENGINEERING, Robert Howell

______________________ CHIEF, OPERATIONS, Joe Hrametz

______________________ CHIEF, CONSTRUCTION, Don Carelock

______________________ CHIEF, CONTRACTING, John Eugino

______________________ CHIEF, PM-J, Valerie Miller

______________________ CHIEF, DPM, Pete Perez

ESTIMATED FEDERAL COST: **$255,256**
ESTIMATED NON-FEDERAL COST: **$67,632**

ESTIMATED TOTAL PROJECT COST: **$322,888**

****** TOTAL PROJECT COST SUMMARY ******

****** CONTRACT COST SUMMARY ******

PROJECT: LPP - Freeport Harbor, Deepening and Selective Widening
LOCATION: Freeport, Texas
This Estimate reflects the scope and schedule in report; Project Feasibility Report

DISTRICT: Galveston District PREPARED: 3/30/2012
POC: CHIEF, COST ENGINEERING, Willie Joe Honza

	Estimate Prepared:	30-Mar-12					Program Year (Budget EC):	2014						
	Effective Price Level:	1-Oct-11					Effective Price Level Date:	1 OCT 13		FULLY FUNDED PROJECT ESTIMATE				
				RISK BASED										
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	Cont #1 - Future Ch Ext &Half of Outer Bar Ch													
12	NAVIGATION PORTS & HARBORS													
12	Hopper Dredge	$45,415	$10,900	24%	$56,315	3.0%	$46,764	$11,223	$57,988	2015Q4	3.1%	$48,217	$11,572	$59,789
12	Navigation Aids	$90	$22	24%	$112	3.0%	$93	$22	$115	2015Q4	3.1%	$96	$23	$118
	CONSTRUCTION ESTIMATE TOTALS:	$45,505	$10,921	24%	**$56,426**		$46,857	$11,246	$58,103			$48,312	$11,595	$59,907
01	LANDS AND DAMAGES													
30	PLANNING, ENGINEERING & DESIGN													
0.5%	Project Management	$228	$55	24%	$283	4.1%	$237	$57	$294	2014Q4	2.8%	$244	$59	$303
0.8%	Planning & Environmental Compliance	$364	$87	24%	$451	4.1%	$379	$91	$470	2014Q4	2.8%	$390	$93	$483
3.0%	Engineering & Design	$1,365	$328	24%	$1,693	4.1%	$1,421	$341	$1,762	2014Q4	2.8%	$1,461	$351	$1,811
0.8%	Engineering Tech Review ITR & VE	$341	$82	24%	$423	4.1%	$355	$85	$440	2014Q4	2.8%	$365	$88	$453
0.8%	Contracting & Reprographics	$364	$87	24%	$451	4.1%	$379	$91	$470	2014Q4	2.8%	$390	$93	$483
0.8%	Engineering During Construction	$364	$87	24%	$451	4.1%	$379	$91	$470	2015Q4	6.9%	$405	$97	$502
	Real Estate In-House Labor			24%										
	Project Operations			24%										
31	CONSTRUCTION MANAGEMENT													
3.0%	Construction Management	$1,365	$328	24%	$1,693	4.1%	$1,421	$341	$1,762	2015Q4	6.9%	$1,518	$364	$1,883
	Project Operation:			24%										
0.5%	Project Management	$228	$55	24%	$283	4.1%	$237	$57	$294	2015Q4	6.9%	$254	$61	$314
	CONTRACT COST TOTALS:	$50,124	$12,030		**$62,154**		$51,665	$12,399	$64,064			$53,338	$12,801	**$66,139**

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: LPP - Freeport Harbor, Deepening and Selective Widening
LOCATION: Freeport, Texas
This Estimate reflects the scope and schedule in report; Project Feasibility Report

DISTRICT: Galveston District PREPARED: 3/30/2012
POC: CHIEF, COST ENGINEERING, Willie Joe Honza

Estimate Prepared: 30-Mar-12
Effective Price Level: 1-Oct-11

Program Year (Budget EC): 2014
Effective Price Level Date: 1 OCT 13

FULLY FUNDED PROJECT ESTIMATE

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	Contract #2 - Half of Outer Bar Ch & Jetty Ch													
12	NAVIGATION PORTS & HARBORS													
12	Hopper Dredge	$72,311	$17,355	24%	$89,666	3.0%	$74,460	$17,870	$92,330	2017Q1	5.4%	$78,494	$18,839	$97,332
12	Navigation Aids	$1,000	$240	24%	$1,240	3.0%	$1,030	$247	$1,277	2017Q1	5.4%	$1,086	$261	$1,346
	CONSTRUCTION ESTIMATE TOTALS:	$73,311	$17,595	24%	**$90,906**		$75,489	$18,117	$93,607			$79,579	$19,099	$98,678
01	LANDS AND DAMAGES													
30	PLANNING, ENGINEERING & DESIGN													
0.5%	Project Management	$367	$88	24%	$455	4.1%	$382	$92	$474	2015Q2	4.8%	$400	$96	$496
0.8%	Planning & Environmental Compliance	$586	$141	24%	$727	4.1%	$610	$146	$756	2015Q2	4.8%	$639	$153	$793
3.0%	Engineering & Design	$2,199	$528	24%	$2,727	4.1%	$2,289	$549	$2,838	2015Q2	4.8%	$2,399	$576	$2,975
0.8%	Engineering Tech Review ITR & VE	$550	$132	24%	$682	4.1%	$572	$137	$710	2015Q2	4.8%	$600	$144	$744
0.8%	Contracting & Reprographics	$586	$141	24%	$727	4.1%	$610	$146	$756	2015Q2	4.8%	$639	$153	$793
0.8%	Engineering During Construction	$586	$141	24%	$727	4.1%	$610	$146	$756	2017Q1	12.0%	$683	$164	$847
	Real Estate In-House Labor													
	Project Operations			24%										
31	CONSTRUCTION MANAGEMENT													
3.0%	Construction Management	$2,199	$528	24%	$2,727	4.1%	$2,289	$549	$2,838	2017Q1	12.0%	$2,563	$615	$3,178
	Project Operation:			24%										
0.5%	Project Management	$367	$88	24%	$455	4.1%	$382	$92	$474	2017Q1	12.0%	$428	$103	$530
	CONTRACT COST TOTALS:	$80,751	$19,380		**$100,131**		$83,233	$19,976	$103,209			$87,931	$21,103	**$109,034**

****** TOTAL PROJECT COST SUMMARY ******

PROJECT: LPP - Freeport Harbor, Deepening and Selective Widening
LOCATION: Freeport, Texas
This Estimate reflects the scope and schedule in report; Project Feasibility Report

DISTRICT: Galveston District PREPARED: 3/30/2012
POC: CHIEF, COST ENGINEERING, Willie Joe Honza

Estimate Prepared: 30-Mar-12
Effective Price Level: 1-Oct-11

Program Year (Budget EC): 2014
Effective Price Level Date: 1 OCT 13

FULLY FUNDED PROJECT ESTIMATE

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	Contract #3 -Lower TB													
12	NAVIGATION PORTS & HARBORS													
12	Non-Fed Costs	$9,488	$2,277	24%	$11,765	3.0%	$9,770	$2,345	$12,115	2015Q3	2.6%	$10,028	$2,407	$12,435
12	Federal Cost	$2,325	$558	24%	$2,883	3.0%	$2,394	$575	$2,969	2015Q3	2.6%	$2,457	$590	$3,047
	CONSTRUCTION ESTIMATE TOTALS:	$11,813	$2,835	24%	**$14,648**		$12,164	$2,919	$15,083			$12,486	$2,997	$15,482
01	LANDS AND DAMAGES	$63	$7	11%	$70	3.0%	$65	$7	$72	2015Q2	2.2%	$66	$7	$74
30	PLANNING, ENGINEERING & DESIGN													
0.5%	Project Management	$59	$14	24%	$73	4.1%	$61	$15	$76	2015Q2	4.8%	$64	$15	$80
0.8%	Planning & Environmental Compliance	$95	$23	24%	$118	4.1%	$99	$24	$123	2015Q2	4.8%	$104	$25	$129
3.0%	Engineering & Design	$354	$85	24%	$439	4.1%	$368	$88	$457	2015Q2	4.8%	$386	$93	$479
0.8%	Engineering Tech Review ITR & VE	$89	$21	24%	$110	4.1%	$93	$22	$115	2015Q2	4.8%	$97	$23	$120
0.8%	Contracting & Reprographics	$95	$23	24%	$118	4.1%	$99	$24	$123	2015Q2	4.8%	$104	$25	$129
0.8%	Engineering During Construction	$95	$23	24%	$118	4.1%	$99	$24	$123	2015Q3	5.8%	$105	$25	$130
	Real Estate In-House Labor	$10	$2	20%	$12	4.1%	$10	$2	$12	2015Q3	5.8%	$11	$2	$13
	Project Operations			24%										
31	CONSTRUCTION MANAGEMENT													
3.0%	Construction Management	$354	$85	24%	$439	4.1%	$368	$88	$457	2015Q3	5.8%	$390	$94	$484
0.5%	Project Management	$59	$14	24%	$73	4.1%	$61	$15	$76	2015Q3	5.8%	$65	$16	$81
	CONTRACT COST TOTALS:	$13,086	$3,132		**$16,218**		$13,488	$3,228	$16,717			$13,878	$3,322	**$17,199**

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: LPP - Freeport Harbor, Deepening and Selective Widening
LOCATION: Freeport, Texas
This Estimate reflects the scope and schedule in report; Project Feasibility Report

DISTRICT: Galveston District PREPARED: 3/30/2012
POC: CHIEF, COST ENGINEERING, Willie Joe Honza

Estimate Prepared: 30-Mar-12
Effective Price Level: 1-Oct-11

Program Year (Budget EC): 2014
Effective Price Level Date: 1 OCT 13

FULLY FUNDED PROJECT ESTIMATE

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	Contract #4 - Real Estate PA 8													
11	LEVEES & FLOODWALLS													
04	DAMS													
05	LOCKS													
06	FISH & WILDLIFE FACILITIES													
07	POWER PLANT													
	CONSTRUCTION ESTIMATE TOTALS:													
01	LANDS AND DAMAGES	$480	$48	10%	$528	3.0%	$494	$49	$544	2014Q1		$494	$49	$544
30	PLANNING, ENGINEERING & DESIGN													
0.5%	Project Management													
0.8%	Planning & Environmental Compliance													
3.0%	Engineering & Design													
0.8%	Engineering Tech Review ITR & VE													
0.8%	Contracting & Reprographics													
0.8%	Real Estate In-House Labor	$10	$2	20%	$12	4.1%	$10	$2	$12	2014Q1		$10	$2	$12
0.8%	Engineering During Construction													
	Project Operations													
31	CONSTRUCTION MANAGEMENT													
3.0%	Construction Management													
	Project Operation:													
0.5%	Project Management													
	CONTRACT COST TOTALS:	$490	$50		**$540**		$505	$52	$556			$505	$52	**$556**

****** TOTAL PROJECT COST SUMMARY ******

****** CONTRACT COST SUMMARY ******

PROJECT: LPP - Freeport Harbor, Deepening and Selective Widening
LOCATION: Freeport, Texas
This Estimate reflects the scope and schedule in report; Project Feasibility Report

DISTRICT: Galveston District PREPARED: 3/30/2012
POC: CHIEF, COST ENGINEERING, Willie Joe Honza

	Estimate Prepared: 30-Mar-12 / Effective Price Level: 1-Oct-11					Program Year (Budget EC): 2014 / Effective Price Level Date: 1 OCT 13				FULLY FUNDED PROJECT ESTIMATE				
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	***B***	***C***	***D***	***E***	***F***	***G***	***H***	***I***	***J***	***P***	***L***	***M***	***N***	***O***
	Contract #5 - Dredge Ch to BRZPT through BRZPT TB													
12	NAVIGATION PORTS & HARBORS													
12	Non-Fed Costs	$16,428	$3,943	24%	$20,371	3.0%	$16,916	$4,060	$20,976	2016Q2	4.0%	$17,597	$4,223	$21,820
12	Federal Cost	$23,039	$5,529	24%	$28,568	3.0%	$23,724	$5,694	$29,417	2016Q2	4.0%	$24,678	$5,923	$30,601
	CONSTRUCTION ESTIMATE TOTALS:	$39,467	$9,472	24%	**$48,939**		$40,640	$9,754	$50,393			$42,275	$10,146	$52,421
01	LANDS AND DAMAGES	$28	$3	11%	$31	3.0%	$29	$3	$32	2015Q2	2.2%	$29	$3	$33
30	PLANNING, ENGINEERING & DESIGN													
0.5%	Project Management	$197	$47	24%	$244	4.1%	$205	$49	$254	2015Q2	4.8%	$215	$52	$267
0.8%	Planning & Environmental Compliance	$316	$76	24%	$392	4.1%	$329	$79	$408	2015Q2	4.8%	$345	$83	$427
3.0%	Engineering & Design	$1,184	$284	24%	$1,468	4.1%	$1,232	$296	$1,528	2015Q2	4.8%	$1,292	$310	$1,602
0.8%	Engineering Tech Review ITR & VE	$296	$71	24%	$367	4.1%	$308	$74	$382	2015Q2	4.8%	$323	$78	$400
0.8%	Contracting & Reprographics	$316	$76	24%	$392	4.1%	$329	$79	$408	2015Q2	4.8%	$345	$83	$427
0.8%	Engineering During Construction	$316	$76	24%	$392	4.1%	$329	$79	$408	2016Q2	8.9%	$358	$86	$444
	Real Estate In-House Labor	$11	$2	18%	$13	4.1%	$11	$2	$14	2016Q2	8.9%	$12	$2	$15
	Project Operations													
31	CONSTRUCTION MANAGEMENT													
3.0%	Construction Management	$1,184	$284	24%	$1,468	4.1%	$1,232	$296	$1,528	2016Q2	8.9%	$1,342	$322	$1,664
0.5%	Project Management	$197	$47	24%	$244	4.1%	$205	$49	$254	2016Q2	8.9%	$223	$54	$277
	CONTRACT COST TOTALS:	$43,512	$10,439		**$53,951**		$44,849	$10,759	$55,609			$46,759	$11,218	**$57,977**

****** TOTAL PROJECT COST SUMMARY ******

PROJECT: LPP - Freeport Harbor, Deepening and Selective Widening
LOCATION: Freeport, Texas
This Estimate reflects the scope and schedule in report; Project Feasibility Report

DISTRICT: Galveston District PREPARED: 3/30/2012
POC: CHIEF, COST ENGINEERING, Willie Joe Honza

Estimate Prepared: 30-Mar-12
Effective Price Level: 1-Oct-11

Program Year (Budget EC): 2014
Effective Price Level Date: 1 OCT 13

FULLY FUNDED PROJECT ESTIMATE

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	Contract #6 - Dredge Ch to Upper TB through Upper TB													
12	NAVIGATION PORTS & HARBORS													
12	Non-Fed Costs	$19,104	$4,585	24%	$23,689	3.0%	$19,672	$4,721	$24,393	2017Q4	6.9%	$21,019	$5,045	$26,064
12	Federal Cost	$10,796	$2,591	24%	$13,387	3.0%	$11,117	$2,668	$13,785	2017Q4	6.9%	$11,878	$2,851	$14,729
	CONSTRUCTION ESTIMATE TOTALS:	$29,900	$7,176	24%	**$37,076**		$30,788	$7,389	$38,178			$32,898	$7,895	$40,793
01	LANDS AND DAMAGES	$785	$79	10%	$864	3.0%	$808	$81	$890	2016Q3	4.5%	$845	$85	$930
30	PLANNING, ENGINEERING & DESIGN													
0.5%	Project Management	$150	$36	24%	$186	4.1%	$156	$37	$194	2016Q3	9.9%	$172	$41	$213
0.8%	Planning & Environmental Compliance	$239	$57	24%	$296	4.1%	$249	$60	$308	2016Q3	9.9%	$273	$66	$339
3.0%	Engineering & Design	$897	$215	24%	$1,112	4.1%	$934	$224	$1,158	2016Q3	9.9%	$1,026	$246	$1,273
0.8%	Engineering Tech Review ITR & VE	$224	$54	24%	$278	4.1%	$233	$56	$289	2016Q3	9.9%	$256	$62	$318
0.8%	Contracting & Reprographics	$239	$57	24%	$296	4.1%	$249	$60	$308	2016Q3	9.9%	$273	$66	$339
	Real Estate In-House Labor	$27	$3	11%	$30	4.1%	$28	$3	$31	2016Q3	9.9%	$31	$3	$34
0.8%	Engineering During Construction	$239	$57	24%	$296	4.1%	$249	$60	$308	2017Q4	15.0%	$286	$69	$355
											15.0%			
	Project Operations													
31	CONSTRUCTION MANAGEMENT													
3.0%	Construction Management	$897	$215	24%	$1,112	4.1%	$934	$224	$1,158	2017Q4	15.0%	$1,074	$258	$1,332
0.5%	Project Management	$150	$36	24%	$186	4.1%	$156	$37	$194	2017Q4	15.0%	$180	$43	$223
	CONTRACT COST TOTALS:	$33,747	$7,986		**$41,733**		$34,784	$8,232	$43,015			$37,314	$8,834	**$46,148**

****** TOTAL PROJECT COST SUMMARY ******

****** CONTRACT COST SUMMARY ******

PROJECT: LPP - Freeport Harbor, Deepening and Selective Widening
LOCATION: Freeport, Texas
This Estimate reflects the scope and schedule in report; Project Feasibility Report

DISTRICT: Galveston District PREPARED: 3/30/2012
POC: CHIEF, COST ENGINEERING, Willie Joe Honza

Estimate Prepared: 30-Mar-12
Effective Price Level: 1-Oct-11

Program Year (Budget EC): 2014
Effective Price Level Date: 1 OCT 13

FULLY FUNDED PROJECT ESTIMATE

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	Contract #7 -Dredge Stauffer Ch													
12	NAVIGATION PORTS & HARBORS													
12	Non-Fed Costs	$1,092	$262	24%	$1,354	3.0%	$1,124	$270	$1,394	2018Q3	8.3%	$1,218	$292	$1,510
12	Lower Stauffer Ch	$7,612	$1,827	24%	$9,439	3.0%	$7,838	$1,881	$9,719	2018Q3	8.3%	$8,488	$2,037	$10,525
12	Upper Stauffer Ch	$2,525	$606	24%	$3,131	3.0%	$2,600	$624	$3,224	2016Q1	3.6%	$2,692	$646	$3,339
	CONSTRUCTION ESTIMATE TOTALS:	$11,229	$2,695	24%	**$13,924**		$11,563	$2,775	$14,338			$12,398	$2,975	$15,373
01	LANDS AND DAMAGES	$135	$25	19%	$160	3.0%	$139	$26	$165	2017Q1	5.4%	$147	$27	$174
30	PLANNING, ENGINEERING & DESIGN													
0.5%	Project Management	$56	$13	24%	$69	4.1%	$58	$14	$72	2017Q1	12.0%	$65	$16	$81
0.8%	Planning & Environmental Compliance	$90	$22	24%	$112	4.1%	$94	$22	$116	2017Q1	12.0%	$105	$25	$130
3.0%	Engineering & Design	$337	$81	24%	$418	4.1%	$351	$84	$435	2017Q1	12.0%	$393	$94	$487
0.8%	Engineering Tech Review ITR & VE	$84	$20	24%	$104	4.1%	$87	$21	$108	2017Q1	12.0%	$98	$23	$121
0.8%	Contracting & Reprographics	$90	$22	24%	$112	4.1%	$94	$22	$116	2017Q1	12.0%	$105	$25	$130
	Real Estate In-House Labor	$115	$50	43%	$165	4.1%	$120	$52	$172	2017Q1	18.1%	$141	$61	$203
0.8%	Engineering During Construction	$90	$22	24%	$112	4.1%	$94	$22	$116	2018Q3	18.1%	$111	$27	$137
31	CONSTRUCTION MANAGEMENT													
3.0%	Construction Management	$337	$81	24%	$418	4.1%	$351	$84	$435	2018Q3	18.1%	$414	$99	$514
0.5%	Project Management	$56	$13	24%	$69	4.1%	$58	$14	$72	2018Q3	18.1%	$69	$17	$85
	CONTRACT COST TOTALS:	$12,619	$3,044		**$15,663**		$13,008	$3,138	$16,145			$14,045	$3,390	**$17,436**

****** TOTAL PROJECT COST SUMMARY ******

****** CONTRACT COST SUMMARY ******

PROJECT: LPP - Freeport Harbor, Deepening and Selective Widening
LOCATION: Freeport, Texas
This Estimate reflects the scope and schedule in report; Project Feasibility Report

DISTRICT: Galveston District PREPARED: 3/30/2012
POC: CHIEF, COST ENGINEERING, Willie Joe Honza

Estimate Prepared: 30-Mar-12
Effective Price Level: 1-Oct-11

Program Year (Budget EC): 2014
Effective Price Level Date: 1 OCT 13

FULLY FUNDED PROJECT ESTIMATE

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	Contract #8 - PA Mitigation													
06	FISH & WILDLIFE FACILITIES	$130	$31	24%	$ 161	3.0%	$134	$32	$166	2018Q3	8.3%	$145	$35	$180
	CONSTRUCTION ESTIMATE TOTALS:	$130	$31	24%	**161**		$134	$32	$166			$145	$35	$180
01	LANDS AND DAMAGES													
30	PLANNING, ENGINEERING & DESIGN													
5.0%	Project Management	$7	$2	24%	9	4.1%	$7	$2	$9	2017Q1	12.0%	$8	$2	$10
5.0%	Planning & Environmental Compliance	$7	$2	24%	9	4.1%	$7	$2	$9	2017Q1	12.0%	$8	$2	$10
20.0%	Engineering & Design	$26	$6	24%	32	4.1%	$27	$6	$34	2017Q1	12.0%	$30	$7	$38
5.0%	Engineering Tech Review ITR & VE	$7	$2	24%	9	4.1%	$7	$2	$9	2017Q1	12.0%	$8	$2	$10
	Real Estate In-House Labor													
5.0%	Contracting & Reprographics	$7	$2	24%	9	4.1%	$7	$2	$9	2017Q1	12.0%	$8	$2	$10
5.0%	Engineering During Construction	$7	$2	24%	9	4.1%	$7	$2	$9	2018Q3	18.1%	$9	$2	$11
31	CONSTRUCTION MANAGEMENT													
10.0%	Construction Management	$13	$3	24%	16	4.1%	$14	$3	$17	2018Q3	18.1%	$16	$4	$20
	Project Operation:			24%										
5.0%	Project Management	$7	$2	24%	9	4.1%	$7	$2	$9	2018Q3	18.1%	$9	$2	$11
	CONTRACT COST TOTALS:	$211	$51		**262**		$218	$52	$271			$241	$58	**$299**

WALLA WALLA COST ENGINEERING TECHNICAL CENTER OF EXPERTISE

COST AGENCY TECHNICAL REVIEW

CERTIFICATION STATEMENT

For

SWG – Freeport Harbor
Deepening & Selective Widening

The Freeport Harbor Deepening & Selective Widening as presented by Galveston District has undergone a successful Cost Agency Technical Review (Cost ATR) update, performed by the Walla Walla District Cost Engineering Technical Center of Expertise (Cost TCX) team. The Cost ATR included study of the project scope, report, cost estimates, schedules, escalation, and risk-based contingencies. This certification signifies the products meet the quality standards as prescribed in ER 1110-2-1150 Engineering and Design for Civil Works Projects and ER 1110-2-1302 Civil Works Cost Engineering.

As of May 2, 2012, the Cost TCX RE-Certifies the estimated total project cost of:

NED
FY 2014 Price Level: $403,564,000
Fully Funded Amount: $434,648,000 including spent costs

LPP
FY 2014 Price Level: $299,586,000
Fully Funded Amount: $322,888,000 including spent costs

It remains the responsibility of the District to correctly reflect these cost values within the Final Report and to implement effective project management controls and implementation procedures including risk management throughout the life of the project.

for

Kim C. Callan, PE, CCE, PM1
Chief, Cost Engineering
Walla Walla District

US Army Corps
of Engineers®

**** TOTAL PROJECT COST SUMMARY ****

PROJECT: NED - Freeport Harbor, Deeping and Selective Widening
LOCATION: Freeport, Texas

DISTRICT: Galveston District PREPARED: 3/30/2012
POC: CHIEF, COST ENGINEERING, Willie Joe Honza

This Estimate reflects the scope and schedule in report; Project Feasibility Report

							Program Year (Budget EC): 2014 Effective Price Level Date: 1 OCT 13				TOTAL PROJECT COST (FULLY FUNDED)				
				ESTIMATED COST				PROJECT FIRST COST		Spent Thru:				
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	1-Oct-11 ($K)		COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*K*	*L*	*M*	*N*	*O*
12	NAVIGATION PORTS & HARBORS			-		-								
12	Non- Federal	$46,112	$11,067	24%	$57,179	3.0%	$47,482	$11,396	**$58,878**			$49,959	$11,990	$61,949
12	Federal	$219,834	$52,760	24%	$272,594	3.0%	$226,366	$54,328	**$280,694**			$238,040	$57,130	$295,169
06	FISH & WILDLIFE FACILITIES	$130	$31	24%	$161	3.0%	$134	$32	**$166**			$145	$35	$180
	CONSTRUCTION ESTIMATE TOTALS:	$266,076	$63,858		**$329,934**	3.0%	$273,982	$65,756	**$339,737**			$288,143	$69,154	$357,298
01	LANDS AND DAMAGES	$1,491	$162	11%	$1,653	3.0%	$1,535	$167	**$1,702**			$1,605	$175	$1,780
30	PROJECT EXPENDITURES													
	Non-Federal Cost									4,050				$4,050
	Federal Cost									4,050				$4,050
30	PLANNING, ENGINEERING & DESIGN	$29,486	$7,094	24%	$36,580	4.1%	$30,689	$7,384	**$38,073**			$32,786	$7,891	$40,677
31	CONSTRUCTION MANAGEMENT	$18,636	$4,473	24%	$23,109	4.1%	$19,396	$4,655	**$24,051**			$21,608	$5,186	$26,793
	PROJECT COST TOTALS:	$315,689	$75,587	24%	**$391,276**	3.1%	$325,602	$77,961	**$403,564**	8,100		$344,143	$82,406	$434,648

ESTIMATED FEDERAL COST:	**$366,869**
ESTIMATED NON-FEDERAL COST:	**$67,779**
ESTIMATED TOTAL PROJECT COST:	**$434,648**

_______________ CHIEF, COST ENGINEERING, Willie Joe Honza

_______________ PROJECT MANAGER, Sharon Tirpak

_______________ CHIEF, REAL ESTATE, Orlando Rosa

_______________ CHIEF, PLANNING, Dolan Dunn

_______________ CHIEF, ENGINEERING, Robert Howell

_______________ CHIEF, OPERATIONS, Joe Hrametz

_______________ CHIEF, CONSTRUCTION, Don Carelock

_______________ CHIEF, CONTRACTING, John Eugino

_______________ CHIEF, PM-J, Valerie Miller

_______________ CHIEF, DPM, Pete Perez

**** TOTAL PROJECT COST SUMMARY ****

PROJECT: LPP - Freeport Harbor, Deeping and Selective Widening
LOCATION: Freeport, Texas

DISTRICT: Galveston District PREPARED: 3/30/2012
POC: CHIEF, COST ENGINEERING, Willie Joe Honza

This Estimate reflects the scope and schedule in report; Project Feasibility Report

		ESTIMATED COST				Program Year (Budget EC): 2014 / Effective Price Level Date: 1 OCT 13 / PROJECT FIRST COST				TOTAL PROJECT COST (FULLY FUNDED)				
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 31-Mar-12 ($K)		COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*K*	*L*	*M*	*N*	*O*
12	NAVIGATION PORTS & HARBORS			-		-								
12	Non- Federal	$46,112	$11,067	24%	$57,179	3.0%	$47,482	$11,396	**$58,878**			$49,862	$11,967	$61,829
12	Federal	$165,113	$39,627	24%	$204,740	3.0%	$170,019	$40,805	**$210,823**			$178,086	$42,741	$220,826
06	FISH & WILDLIFE FACILITIES	$130	$31	24%	$161	3.0%	$134	$32	**$166**			$145	$35	$180
	CONSTRUCTION ESTIMATE TOTALS:	$211,355	$50,725		**$262,080**	3.0%	$217,635	$52,232	**$269,867**			$228,093	$54,742	$282,835
01	LANDS AND DAMAGES	$1,491	$162	11%	$1,653	3.0%	$1,535	$167	**$1,702**			$1,581	$172	$1,753
30	PROJECT EXPENDITURES													
	Non-Federal Cost									4,050				$4,050
	Federal Cost									4,050				$4,050
30	PLANNING, ENGINEERING & DESIGN	$14,281	$3,445	24%	$17,726	4.1%	$14,864	$3,585	**$18,449**			$15,793	$3,812	$19,606
31	CONSTRUCTION MANAGEMENT	$7,413	$1,779	24%	$9,192	4.1%	$7,715	$1,852	**$9,567**			$8,544	$2,051	$10,595
	PROJECT COST TOTALS:	$234,540	$56,111	24%	**$290,651**	3.1%	$241,749	$57,836	**$299,586**	8,100		$254,011	$60,777	$322,888

______________________ CHIEF, COST ENGINEERING, Willie Joe Honza

______________________ PROJECT MANAGER, Sharon Tirpak

______________________ CHIEF, REAL ESTATE, Orlando Rosa

______________________ CHIEF, PLANNING, Dolan Dunn

______________________ CHIEF, ENGINEERING, Robert Howell

______________________ CHIEF, OPERATIONS, Joe Hrametz

______________________ CHIEF, CONSTRUCTION, Don Carelock

______________________ CHIEF, CONTRACTING, John Eugino

______________________ CHIEF, PM-J, Valerie Miller

______________________ CHIEF, DPM, Pete Perez

ESTIMATED FEDERAL COST:	**$255,256**
ESTIMATED NON-FEDERAL COST:	**$67,632**
ESTIMATED TOTAL PROJECT COST:	**$322,888**

FEASIBILITY STUDY FOR
DEEPENING AND WIDENING
FREEPORT , TEXAS
WITH OUT PROJECT - COST SUMMARY
50 Year O &M Cost
October 2011 Price Levels

	Cycle	Sta -300+00 to 71+52	Sta 71+52 to 256+00
O&M Costs			
Year 1		10,433,719	
Year 2		10,433,719	
Year 3	1	10,433,719	3,168,410
Year 4		10,433,719	
Year 5		10,433,719	
Year 6	2	10,433,719	3,629,085
Year 7		10,433,719	
Year 8		10,433,719	
Year 9	3	10,433,719	3,721,385
Year 10		10,433,719	
Year 11		10,433,719	
Year 12	4	10,433,719	2,531,085
Year 13		10,433,719	
Year 14		10,433,719	
Year 15	5	10,433,719	3,645,160
Year 16		10,433,719	
Year 17		10,433,719	
Year 18	6	10,433,719	3,734,660
Year 19		10,433,719	
Year 20		10,433,719	
Year 21	7	10,433,719	2,531,085
Year 22		10,433,719	
Year 23		10,433,719	
Year 24	8	10,433,719	3,652,835
Year 25		10,433,719	687,700
Year 26		10,433,719	
Year 27	9	10,433,719	3,745,135
Year 28		10,433,719	
Year 29		10,433,719	
Year 30	10	10,433,719	2,531,085
Year 31		10,433,719	
Year 32		10,433,719	
Year 33	11	10,433,719	3,658,010
Year 34		10,433,719	
Year 35		10,433,719	
Year 36	12	10,433,719	3,895,135
Year 37		10,433,719	
Year 38		10,433,719	
Year 39	13	10,433,719	2,531,085
Year 40		10,433,719	
Year 41		10,433,719	
Year 42	14	10,433,719	3,645,160
Year 43		10,433,719	
Year 44		10,433,719	
Year 45	15	10,433,719	3,729,160
Year 46		10,433,719	
Year 47		10,433,719	
Year 48	16	10,433,719	2,531,085
Year 49		10,433,719	
Year 50		10,433,719	
TOTAL :		**$ 521,685,950**	**$ 53,567,260**

TOTAL O&M COST : $ 575,253,210

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FEASIBILITY STUDY FOR
DEEPENING AND WIDENING
FREEPORT , TEXAS
NED 50 Year O&M Cost
October 2011 PRICE LEVEL

	Cycle	Hopper Dredge Reach	Sta 71+52 to 90+20 (PA 1)	Sta 90+20 to 132+66 (PA 8)	Sta 132+66 to 184+20 (PA 9)	Sta 184+20 to 222+00 (Lw ST)	Sta 222+00 to 260+00 (Up ST)	Mitgation Cost
O&M Costs								
Year 1		21,377,935						46,640
Year 2		21,377,935						19,910
Year 3	1	21,377,935	1,280,535	3,287,371	5,147,911			119,240
Year 4		21,377,935						19,910
Year 5		21,377,935						38,566
Year 6	2	21,377,935	1,280,535	2,043,383	2,583,923			10,010
Year 7		21,377,935						10,010
Year 8		21,377,935						10,010
Year 9	3	21,377,935	1,280,535	2,043,383	2,583,923			10,010
Year 10		21,377,935						28,666
Year 11		21,377,935						10,010
Year 12	4	21,377,935	1,280,535	2,043,383	2,583,923	956,333	631,335	10,010
Year 13		21,377,935						10,010
Year 14		21,377,935						10,010
Year 15	5	21,377,935	1,280,535	2,043,383	2,583,923			28,666
Year 16		21,377,935						
Year 17		21,377,935						
Year 18	6	21,377,935	1,280,535	2,043,383	2,583,923			
Year 19		21,377,935						
Year 20		21,377,935						2,156
Year 21	7	21,377,935	1,280,535	2,043,383	2,583,923			
Year 22		21,377,935						
Year 23		21,377,935						
Year 24	8	21,377,935	1,280,535	2,043,383	2,583,923	956,333	631,335	
Year 25		21,377,935	687,700	687,700	687,700			2,156
Year 26		21,377,935						
Year 27	9	21,377,935	2,233,398	2,043,383	2,583,923			
Year 28		21,377,935						
Year 29		21,377,935						
Year 30	10	21,377,935	1,280,535	2,043,383	2,583,923			2,156
Year 31		21,377,935						
Year 32		21,377,935						
Year 33	11	21,377,935	1,280,535	2,043,383	2,583,923			
Year 34		21,377,935						
Year 35		21,377,935						2,156
Year 36	12	21,377,935	1,280,535	2,043,383	2,583,923	956,333	631,335	
Year 37		21,377,935						
Year 38		21,377,935						
Year 39	13	21,377,935	1,280,535	2,043,383	2,583,923			
Year 40		21,377,935						2,156
Year 41		21,377,935						
Year 42	14	21,377,935	1,280,535	2,043,383	2,583,923			
Year 43		21,377,935						
Year 44		21,377,935						
Year 45	15	21,377,935	1,280,535	2,043,383	2,583,923			2,156
Year 46		21,377,935						
Year 47		21,377,935						
Year 48	16	21,377,935	1,280,535	2,043,383	2,583,923	956,333	631,335	
Year 49		21,377,935						
Year 50		21,377,935	687,700	687,700	687,700			2,156
TOTAL O&M:		$ 1,068,896,750	$ 22,816,823	$ 35,313,516	$ 45,282,156	$ 3,825,332	$ 2,525,340	$ 396,770
Adaptive Mngt								210,210
TAL O&M:		**$ 1,068,896,750**	**$ 22,816,823**	**$ 35,313,516**	**$ 45,282,156**	**$ 3,825,332**	**$ 2,525,340**	**$ 606,980**

TAL O&M COST : $ 1,179,266,897

FEASIBILITY STUDY FOR
DEEPENING AND WIDENING
FREEPORT , TEXAS
LPP 50 Year O&M Cost
October 2011 PRICE LEVEL

	Cycle	Hopper Dredge Reach	Sta 78+52 to 90+20 (PA 1)	Sta 89+10 to 123+40 (PA 8)	Sta 132+66 to 184+20 (PA 9)	Sta 184+20 to 222+00 (Lw ST)	Sta 222+00 to 260+00 (Up ST)	Mitgation Cost
O&M Costs								
Year 1		19,722,415						46,640
Year 2		19,722,415						19,910
Year 3	1	19,722,415	1,280,535	3,287,371	5,147,911			119,240
Year 4		19,722,415						19,910
Year 5		19,722,415						38,566
Year 6	2	19,722,415	1,280,535	2,043,383	2,583,923			10,010
Year 7		19,722,415						10,010
Year 8		19,722,415						10,010
Year 9	3	19,722,415	1,280,535	2,043,383	2,583,923			10,010
Year 10		19,722,415						28,666
Year 11		19,722,415						10,010
Year 12	4	19,722,415	1,280,535	2,043,383	2,583,923	956,333	631,335	10,010
Year 13		19,722,415						10,010
Year 14		19,722,415						10,010
Year 15	5	19,722,415	1,280,535	2,043,383	2,583,923			28,666
Year 16		19,722,415						
Year 17		19,722,415						
Year 18	6	19,722,415	1,280,535	2,043,383	2,583,923			
Year 19		19,722,415						
Year 20		19,722,415						2,156
Year 21	7	19,722,415	1,280,535	2,043,383	2,583,923			
Year 22		19,722,415						
Year 23		19,722,415						
Year 24	8	19,722,415	1,280,535	2,043,383	2,583,923	956,333	631,335	
Year 25		19,722,415	687,700	687,700	687,700			2,156
Year 26		19,722,415						
Year 27	9	19,722,415	2,233,398	2,043,383	2,583,923			
Year 28		19,722,415						
Year 29		19,722,415						
Year 30	10	19,722,415	1,280,535	2,043,383	2,583,923			2,156
Year 31		19,722,415						
Year 32		19,722,415						
Year 33	11	19,722,415	1,280,535	2,043,383	2,583,923			
Year 34		19,722,415						
Year 35		19,722,415						2,156
Year 36	12	19,722,415	1,280,535	2,043,383	2,583,923	956,333	631,335	
Year 37		19,722,415						
Year 38		19,722,415						
Year 39	13	19,722,415	1,280,535	2,043,383	2,583,923			
Year 40		19,722,415						2,156
Year 41		19,722,415						
Year 42	14	19,722,415	1,280,535	2,043,383	2,583,923			
Year 43		19,722,415						
Year 44		19,722,415						
Year 45	15	19,722,415	1,280,535	2,043,383	2,583,923			2,156
Year 46		19,722,415						
Year 47		19,722,415						
Year 48	16	19,722,415	1,280,535	2,043,383	2,583,923	956,333	631,335	
Year 49		19,722,415						
Year 50		19,722,415	687,700	687,700	687,700			2,156
TOTAL O&M:		$ 986,120,750	$ 22,816,823	$ 35,313,516	$ 45,282,156	$ 3,825,332	$ 2,525,340	$ 396,770
Adaptive Mngt								210,210
TOTAL O&M:		**$ 986,120,750**	**$ 22,816,823**	**$ 35,313,516**	**$ 45,282,156**	**$ 3,825,332**	**$ 2,525,340**	**$ 606,980**

TOTAL O&M COST : $ 1,096,490,897

Appendix C

Real Estate Plan

GALVESTON DISTRICT REAL ESTATE PLAN

FREEPORT HARBOR

CHANNEL IMPROVEMENT PROJECT

BRAZORIA COUNTY, TEXAS

JUNE 2011

REVISED JULY 2012

CESWG-RE (MAY 2012)
Project Manager: CESWG-PE-PL Robert Van Hook
Prepared by: CESWG-RE-T Kenny Pablo
Submitted by: CESWG-RE-T Jody Rowe

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REAL ESTATE PLAN
FREEPORT HARBOR
CHANNEL IMPROVEMENT PROJECT
BRAZORIA COUNTY, TEXAS

1. General Background. This Real Estate Plan (REP) is the real estate work product of the U.S. Army Corps of Engineers, Galveston District, Real Estate Division (the "District") that supports project plan formulation for the Freeport Harbor Channel Improvement Project (the "Project"). It identifies and describes the lands, easements, and rights-of-way (LER) required for the construction, operation, and maintenance of the proposed project, including those required for relocations, borrow material, and dredged or excavated material disposal. Further, the REP describes the estimated LER value, together with the estimated administrative and incidental costs attributable to providing project LER, and the acquisition process.

2. Project Type & Applicability. The Galveston District of the Corps is currently conducting a feasibility study of the navigation improvements at the Harbor that are addressing both increased channel width and depth under the authority of River and Harbor Act of 1970 and Section 216 of the Flood Control Act of 1970, which authorizes investigations for modification of completed projects or their operation when found advisable due to significantly changed physical or economic conditions and for improving the quality of the environment in the overall public interest. Because of the local interest in expediting improvements for the harbor, Port of Freeport, is proposing to implement a deepening and selective widening project at its expense with the request that the Federal Government accept responsibility for future Operation and Maintenance (O&M) of the deepening and selective widening project. Authority for the non-Federal interests to conduct the feasibility study is provided in Section 203 of WRDA 1986 (PL99-662). The non-Federal interests are constructing the deepening and selective widening project under the Authority of Section 204(a) of WRDA 1986, as amended. The non-Federal interests are asking the Federal Government to assume O&M of the completed project under Section 204(f) of WRDA 1986. This Report identifies real estate interests required for the for both the National Economic Development (NED) and Locally Preferred Plan (LLP) alternatives.

3. Project Location. The Freeport Harbor Channel is 40 miles south and west of Galveston, Texas. It is a deep-draft navigation project, which connects harbor facilities in the Freeport Area with the Gulf of Mexico. The project study area is situated in Brazoria County, Texas

4. Scope and Content. The Feasibility Report describes a range of potential alternative channel widths and depths for the Entrance and Jetty channels up to a maximum of 600 feet. The report describes both the NED Plan and LPP.

The NED Plan is referred to as the 60-foot by 540-foot project because the width of the Jetty Channel would be restricted to 540 feet. This alternative proposes to extend the Outer Bar Channel (Channel Extension) 3.2 miles farther into the Gulf of Mexico at a depth of 62 feet and a width of 600 feet, deepen the existing Outer Bar Channel to 62 feet and the Jetty Channel to 60 feet, deepen the Lower Turning Basin and Main Channel through Station 132+66 (just above the Brazosport Turning Basin) to 60 feet and widen the Brazosport Turning Basin to 1,200 feet, deepen the channel from Station 132+66 through the Upper Turning Basin to 50 feet, deepen and widen the Lower Stauffer Channel to 50 feet by 300 feet, and dredge the Upper Stauffer Channel to 25 feet deep by 200 feet wide in lieu of restoring its previously authorized dimensions of 30 feet by 200 feet. The NED plan's total new work dredging quantity will be 20.4 million cubic yards (mcy).

The LPP is referred to as the 55-foot by 600-foot project. This alternative proposes to extend the Outer Bar Channel (Channel Extension) 1.3 miles farther into the Gulf of Mexico at a depth of 57 feet and a width of 600 feet, deepen the existing Outer Bar Channel to 57 feet and the Jetty Channel to 55 feet, deepen the Lower Turning Basin and Main Channel through Station 132+66 (just above the Brazosport Turning Basin) to 55 feet and widen the Brazosport Turning Basin to 1,200 feet, deepen the channel from Station 132+66 through the Upper Turning Basin to 50 feet, deepen and widen the Lower Stauffer Channel to 50 feet by 300 feet wide, and dredge the Upper Stauffer Channel to 25 feet deep by 200 feet wide in lieu of restoring its previously authorized dimensions of 30 feet by 200 feet. The LPP's total new work dredge quantity will be 14.3 mcy.

From the Gulf of Mexico working upstream, the reaches are: 1) New Extension and Part of Entrance Channel, 2) Entrance Channel and Jetty Channel, 3) Lower Turning Basin, 4) Channel to Brazosport thru Brazosport Turning Basin, 5) Channel to Upper Turning Basin thru Upper Turning Basin, 6) Stauffer Channel. The total length of the proposed project is 6.1 miles.

5. Purpose. The purpose of the REP is to identify the real estate requirements for both the NED Plan and the LPP and to estimate the costs of acquisition. All project costs were certified in May 2012. The REP costs will be subject to further refinement during Preconstruction Engineering and Design (PED).

This REP also identifies the estate interest to be acquired in the various tracts. The non-Federal sponsor, Port Freeport, already owns all of the lands needed for either the NED or LPP alternative. The Sponsor will receive credit for the fair market value, to be determined in accordance with applicable regulations, of any lands necessary for the Project, which it contributes. The Sponsor will also receive credit for the administrative costs of acquisition for all lands acquired within 5 years preceding the signing of the Project Cooperation Agreement.

6. Real Estate Requirements. The Project Sponsor is required to furnish the lands, easements, and rights of way (LER) for the proposed cost-shared project. The real estate requirements must support construction as well as O&M of the project after completion. Of the six sections involved in this project starting with section one, **New Extension and Part of Entrance Channel**, Sta. -150+00 to -435+00, all of the dredged material from this section will be deposited in Offshore PA 1, Section 2, **Entrance Channel and Jetty Channel**, Sta. 71+52.58 to -150+00, all of the dredged material from this section will be deposited in offshore Site 1A, Section 3, **Lower Turning Basin**, Sta. 71+52.58 to 78+52, all of the dredged material from this section will be deposited in upland area PA 1, Section 4, **Channel to Brazosport thru Brazosport Turning Basin**, Sta.78+52 to 115+00, all of the dredged material from this section will be deposited in upland PA 1 and PA 8, Section 5, **Channel to Upper Turning Basin thru Upper Turning Basin**, Sta. 115+00 to 186+00, all of the dredged material from this section will be deposited in PA 9, Section 6, **Stauffer Channel**, Sta. 186+00 to 260+00, the dredged material from this section will be deposited in PA 9. Sufficient LER and PA capacity exists under the NED Plan, such that no additional LER for the Project is required to support the LPP alternative.

Offshore PAs 1 and 1A are in navigable water and will be used by virtue of Navigation Servitude; therefore, no real estate interests will be required. Upland PAs 1, 8, and 9 are owned by the local Sponsor and consist of a total 1,020.98 acres. *(See Exhibit"B", Map Sheet Index)*. Within Section 3 (the Lower Turning Basin), the local Sponsor owns a 7.3-acre tract (approximate). During the initial construction phase, the non-Federal sponsor will allow the Government right-of-entry to this tract in order to complete the requirement of cutting away and removing of material.

Consistent with the current policy of the USACE, the non-Federal Sponsor will provide fee title for disposal areas and mitigation areas located on fast land and a standard perpetual Channel Improvement Easement on the 7.3-acre tract. For the initial construction, the non- Federal sponsor will provide an authorization of entry to the Government and the Government will require the Non-Federal Sponsor to provide recordable instruments applicable to such sites, as it deems necessary, in order to place the general public on notice of the project requirements and to protect Government operations from interference by third parties.

7. Borrow Material. The proposed project does not require any borrow material. All material needed for the construction of the placement area levees will be borrowed from within the footprint of the proposed placement area.

8. Access/Staging Area. The proposed NED Plan and the LPP do not require any Access/Staging Areas. All of the proposed work will be performed within the existing property owned by the Sponsor and existing roads and highways within the project area. No credit will be allowed for access/staging areas since these areas fall within the boundary lines of the land acquired for the PAs. The Sponsor will get credit for the entire tract acquired for the required PAs needed for the project.

9. Recreation Features. The proposed project does not have any recreation features.

10. Induced Flooding. There will be no induced flooding by virtue of the construction of the project. The proposed project will be constructed within the existing right-of-way of the Freeport Harbor Channel.

11. Mitigation. The proposed mitigation is contained within the boundary of the tract acquired for PA 9. Both mitigation features and conservation of existing land falls in the upper part of said tract. No credit will be allowed for mitigation/conservation area since this area falls within the boundary lines of the tract of land acquired for the PA. The Sponsor will get credit for the entire tract acquired for the required PA 9 placement area needed for the project.

12. Federally Owned Land & Existing Federal Project. There is no federally owned land in the project area.

13. Navigation Servitude. Navigation Servitude emanated from the Commerce Clause of the Constitution of the United States, Article I; Section 8, Clause 3. The servitude gives the Federal Government the right to use the "Navigable Waters" of the United States without compensation for navigation projects. These are nontransferable rights and are not considered interest in real property. The proposed project proposes to use two offshore PAs located in navigable waters. Therefore, there are no real estate requirements associated with these sites.

14. Public Law 91-646 Relocations. There are no residential houses, businesses, or farms that would be required for relocation associated with PL 91-646.

15. Assessment of Project Sponsor Land Acquisition Capabilities. The local sponsor, the Port of Freeport has the authority and capability to furnish lands, easements, and rights-of-way in accordance with the Feasibility Cost-Sharing Agreement. The non-Federal sponsor is highly capable of performing the real estate acquisition required by this project. A copy of the non-Federal capability assessment is attached as *Exhibit "A."*

16. Baseline Cost Estimate for Real Estate. The costs listed in the tables to follow reflect the estimated real estate costs for the proposed navigation project. There is only one set of estimated costs, as there is no difference in the real estate requirements between the NED and LPP alternatives. Estimated costs include land payments authorized by LERRDs and administrative costs incidental to acquisition, for example surveying, mapping, and appraisals. Other costs, such as audits and project administration, are provided to establish total project cost estimates, but are not incidental costs of acquiring project lands and are not creditable as LERRDs.

Federal costs that previously would have been identified as Federal 01 Account costs have been relabeled Real Estate In-House Labor and recoded under the 30 Account to clarify that these are Federal labor costs and not Federal land acquisition costs.

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Contracts 1-2 are in open water, no Real Estate involved

CONSTRUCTION CONTRACT #3			
Lower Turning Basin Sta. 71+52 to 78+52 (PA 1)			
NON-FED COST		**AMOUNT**	**CONTINGENCY**
	Acquisition	$20,000.00	$2,000.00
	Appraisals	$3,500.00	$350.00
	Audits	$500.00	$0.00
	Proj Related Admin	$1,500.00	$225.00
	Land Payments	$35,937.00	$3,993.00
	LEERD Crediting	$1,500.00	$225.00
NON-FED TOTAL		**$62,937.00**	**$6,793.00**
FED COST		**AMOUNT**	**CONTINGENCY**
	Acquisition	$2,000.00	$225.00
	Appraisal	$1,500.00	$225.00
	Audits	$1,500.00	$225.00
	Real Property Accountability	$1,500.00	$225.00
	Proj Related Admin	$2,000.00	$225.00
	LERRDs Crediting	$1,500.00	$225.00
FED TOTAL		**$10,000.00**	**$1,350.00**

CONSTRUCTION CONTRACT #4			
PA 8- Jetty Groutin			
NON-FED COST		**AMOUNT**	**CONTINGENCY**
	Acquisition	$20,000.00	$2,000.00
	Appraisals	$3,500.00	$350.00
	Audits	$500.00	$0.00
	Proj Related Admin	$1,500.00	$225.00
	Land Payments	$452,761.00	$45,276.00
	LEERD Crediting	$1,500.00	$225.00
NON-FED TOTAL		**$479,761.00**	**$48,076.00**
FED COST		**AMOUNT**	**CONTINGENCY**
	Acquisition	$2,000.00	$225.00
	Appraisal	$1,500.00	$225.00
	Audits	$1,500.00	$225.00
	Real Property Accountability	$1,500.00	$225.00
	Proj Related Admin	$2,000.00	$225.00
	LERRDs Crediting	$1,500.00	$225.00
FED TOTAL		**$10,000.00**	**$1,350.00**

CONSTRUCTION CONTRACT #5			
Channel to Brazosport thru Brazosport Turning Basin Sta. 78+52 to 115+00 (PA 8)			
NON-FED COST		**AMOUNT**	**CONTINGENCY**
	Acquisition	$20,000.00	$2,000.00
	Appraisals	$3,500.00	$350.00
	Audits	$1,500.00	$375.00
	Real Property Accountability	$1,500.00	$225.00
	LEERD Crediting	$1,500.00	$225.00
NON-FED TOTAL		**$28,000.00**	**$2,800.00**
FED COST		**AMOUNT**	**CONTINGENCY**
	Acquisition	$2,000.00	$225.00
	Appraisal	$1,500.00	$225.00
	Audits	$1,500.00	$225.00
	Real Property Accountability	$2,000.00	$225.00
	Proj Related Admin	$2,000.00	$225.00
	LERRDs Crediting	$2,000.00	$225.00
FED TOTAL		**$11,000.00**	**$1,350.00**

CONSTRUCTION CONTRACT #6			
Channel to Upper Turning Basin thru Upper Turning Basin Sta. 115+00 to 186+00 (PA 9)			
NON-FED COST		**AMOUNT**	**CONTINGENCY**
	Acquisition	$20,000.00	$2,000.00
	Appraisals	$3,500.00	$350.00
	Audits	$1,500.00	$225.00
	Real Property Accountability	$1,500.00	$225.00
	Land Payments	$756,250.00	$75,625.00
	LEERD Crediting	$2,000.00	$225.00
NON-FED TOTAL		**$784,750.00**	**$78,650.00**
FED COST		**AMOUNT**	**CONTINGENCY**
	Acquisition	$20,000.00	$2,000.00
	Appraisal	$1,500.00	$225.00
	Audits	$1,500.00	$225.00
	Real Property Accountability	$2,000.00	$225.00
	LERRDs Crediting	$2,000.00	$225.00
FED TOTAL		**$27,000.00**	**$2,900.00**

CONSTRUCTION CONTRACT #7 **Stauffer Channel Sta. 115+00 to 260+00.**			
NON-FED COST		**AMOUNT**	**CONTINGENCY**
	Land Payments	$135,000.00	$25,000.00
NON-FED TOTAL		**$135,000.00**	**$2,500.00**
FED COST		**AMOUNT**	**CONTINGENCY**
	Proj Related Admin	$20,000.00	$10,000.00
	Facility/Utility Relocations Administration	$80,000.00	$30,000.00
	LERRDs Crediting	$15,000.00	$8,000.00
FED TOTAL		**$115,000.00**	**$48,000.00**

CONSTRUCTION CONTRACT #8 MITIGATION
There are no real estate costs for this contract. Acquisition Costs have been calculated with Contract 7.

17. <u>Acquisition Schedule-</u>The Acquisition of the LER necessary for the Project is the responsibility of the Non-Federal Sponsor, however, for the current project; the Sponsor owns all the lands required for either the NED or LPP alternative. Therefore, there is no need for an acquisition schedule

18. <u>Mineral Activity-</u> There are no known mineral interests within the proposed project area.

19. <u>Facilities/Utilities/Pipelines Relocation-</u>There are 2 known pipelines crossing the channel. One is owned by Freeport LNG and is a recently permitted line already at the required depth requiring no relocation/removal. The other is owned by Enbridge Power Corp. The Port has determined relocation/removal of this pipeline is not required.

20. <u>HTRW or Other Environmental Contaminants-</u>There are no known hazardous or toxic wastes or other environmental contaminants on or within the proposed project area.

21. <u>Attitudes of the Landowner-</u>The Port of Freeport is the owner of all the project lands. As owners they are supportive and in favor of the project. No resistance to the project by the landowner is expected.

22. **<u>Sponsor Notification of Risks-</u>** A letter was transmitted to the Port of Freeport on the 8 of March 2008, advising them if for any reason, the Project Cooperation Agreement (PCA) never gets signed or if Congress fails to authorize or fund the Project, any land they acquired or money they spent in their effort to acquire land will be at their sole risk. *(See Exhibit "A")*

EXHIBIT "A"

APPENDIX 12-E ASSESSMENT OF NON-FEDERAL
SPONSOR'S REAL ESTATE ACQUISITION CAPABILITY

I. <u>Legal Authority:</u>

a. Does the sponsor have legal authority to acquire and hold title to real property for project purposes? (yes/~~no~~)
b. Does the sponsor have the power of eminent domain for this project? (yes/~~no~~)
c. Does the sponsor have "quick-take" authority for this project? (~~yes~~/no)
d. Are any of the lands/interests in land required for the project located outside the sponsor's political boundary? (~~yes~~/no)
e. Are any of the lands/interests in land required for the project owned by an entity whose property the sponsor cannot condemn? (~~ye~~s/no)

II. <u>Human Resources Requirements:</u>

a. Will the sponsor's in-house staff require training to become familiar with the real estate requirements of Federal projects including P.L. 91-646, as amended? (~~yes~~/no)
b. If the answer to II.a. is "yes," has a reasonable plan been developed to provide such training? (yes/~~no~~)
c. Does the sponsor's in-house staff have sufficient real estate acquisition experience to meet its responsibilities for the project? (yes/~~no~~) Is the sponsor's projected in-house staffing level sufficient considering its other work load, if any, and the project schedule? (yes/~~no~~)
d. Can the sponsor obtain contractor support, if required in a timely fashion? (yes/~~no~~)
e. Will the sponsor likely request USACE assistance in acquiring real estate? (~~yes~~/no) (If "yes," provide description.)

III. <u>Other Project Variables:</u>

a. Will the sponsor's staff be located within reasonable proximity to the project site? (yes/~~no~~)
b. Has the sponsor approved the project/real estate schedule/milestones? (yes/~~no~~)

IV. <u>Overall Assessment</u>:

a. Has the sponsor performed satisfactorily on other USACE projects? (yes/~~no~~)

b. With regard to the project, the sponsor is anticipated to be highly capable/~~fully capable/moderately capable/marginally capable/insufficiently capable~~. (If sponsor is believed to be "insufficiently capable," provide explanation.)

EXHIBIT "A"

MAP SHEETS DEPICTING VICINITY OF PROJECT, PLACEMENT AREAS, PIPELINE EASEMENTS, CHANNEL IMPROVEMENT EASEMENTS AND MITIGATION SITES REQUIRED FOR REAL ESTATE INTEREST.

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Appendix D

Baseline Cost Estimate

**** TOTAL PROJECT COST SUMMARY ****

PROJECT: NED - Freeport Harbor, Deepening and Selective Widening
LOCATION: Freeport, Texas

DISTRICT: Galveston District PREPARED: 3/30/2012
POC: CHIEF, COST ENGINEERING, Willie Joe Honza

This Estimate reflects the scope and schedule in report; Project Feasibility Report

		ESTIMATED COST				PROJECT FIRST COST (Program Year (Budget EC): 2014; Effective Price Level Date: 1 OCT 13)				TOTAL PROJECT COST (FULLY FUNDED)				
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	**TOTAL ($K)**	Spent Thru: 1-Oct-11 ($K)		COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*K*	*L*	*M*	*N*	*O*
12	NAVIGATION PORTS & HARBORS		-			-								
12	Non- Federal	$46,112	$11,067	24%	$57,179	3.0%	$47,482	$11,396	**$58,878**			$49,959	$11,990	$61,949
12	Federal	$219,834	$52,760	24%	$272,594	3.0%	$226,366	$54,328	**$280,694**			$238,040	$57,130	$295,169
06	FISH & WILDLIFE FACILITIES	$130	$31	24%	$161	3.0%	$134	$32	**$166**			$145	$35	$180
	CONSTRUCTION ESTIMATE TOTALS:	$266,076	$63,858		**$329,934**	3.0%	$273,982	$65,756	**$339,737**			$288,143	$69,154	$357,298
01	LANDS AND DAMAGES	$1,491	$162	11%	$1,653	3.0%	$1,535	$167	**$1,702**			$1,605	$175	$1,780
30	PROJECT EXPENDITURES													
	Non-Federal Cost									4,050				$4,050
	Federal Cost									4,050				$4,050
30	PLANNING, ENGINEERING & DESIGN	$29,486	$7,094	24%	$36,580	4.1%	$30,689	$7,384	**$38,073**			$32,786	$7,891	$40,677
31	CONSTRUCTION MANAGEMENT	$18,636	$4,473	24%	$23,109	4.1%	$19,396	$4,655	**$24,051**			$21,608	$5,186	$26,793
	PROJECT COST TOTALS:	$315,689	$75,587	24%	**$391,276**	3.1%	$325,602	$77,961	**$403,564**	8,100		$344,143	$82,406	$434,648

________________ CHIEF, COST ENGINEERING, Willie Joe Honza

________________ PROJECT MANAGER, Sharon Tirpak

________________ CHIEF, REAL ESTATE, Orlando Rosa

________________ CHIEF, PLANNING, Dolan Dunn

________________ CHIEF, ENGINEERING, Robert Howell

________________ CHIEF, OPERATIONS, Joe Hrametz

________________ CHIEF, CONSTRUCTION, Don Carelock

________________ CHIEF, CONTRACTING, John Eugino

________________ CHIEF, PM-J, Valerie Miller

________________ CHIEF, DPM, Pete Perez

ESTIMATED FEDERAL COST:	**$366,869**
ESTIMATED NON-FEDERAL COST:	**$67,779**
ESTIMATED TOTAL PROJECT COST:	**$434,648**

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: NED - Freeport Harbor, Deepening and Selective Widening
LOCATION: Freeport, Texas
This Estimate reflects the scope and schedule in report; Project Feasibility Report

DISTRICT: Galveston District PREPARED: 3/30/2012
POC: CHIEF, COST ENGINEERING, Willie Joe Honza

Estimate Prepared: 30-Mar-12
Effective Price Level: 1-Oct-11

Program Year (Budget EC): 2014
Effective Price Level Date: 1 OCT 13

FULLY FUNDED PROJECT ESTIMATE

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	RISK BASED CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	Cont #1 - Future Ch Extension & Half of Outer Bar Ch													
12	NAVIGATION PORTS & HARBORS													
12	Hopper Dredge	$76,232	$18,296	24%	$94,528	3.0%	$78,497	$18,839	$97,336	2016Q2	4.0%	$81,655	$19,597	$101,253
12	Navigation Aids	$90	$22	24%	$112	3.0%	$93	$22	$115	2016Q2	4.0%	$96	$23	$120
	CONSTRUCTION ESTIMATE TOTALS:	$76,322	$18,317	24%	**$94,639**		$78,590	$18,862	$97,451			$81,752	$19,620	$101,372
01	LANDS AND DAMAGES													
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	$763	$183	24%	$946	4.1%	$794	$191	$985	2014Q4	2.8%	$817	$196	$1,013
1.0%	Planning & Environmental Compliance	$763	$183	24%	$946	4.1%	$794	$191	$985	2014Q4	2.8%	$817	$196	$1,013
5.0%	Engineering & Design	$3,816	$916	24%	$4,732	4.1%	$3,972	$953	$4,925	2014Q4	2.8%	$4,084	$980	$5,064
1.0%	Engineering Tech Review ITR & VE	$763	$183	24%	$946	4.1%	$794	$191	$985	2014Q4	2.8%	$817	$196	$1,013
1.0%	Contracting & Reprographics	$763	$183	24%	$946	4.1%	$794	$191	$985	2014Q4	2.8%	$817	$196	$1,013
	Real Estate In-House Labor			26%										
2.0%	Engineering During Construction	$1,526	$366	24%	$1,892	4.1%	$1,588	$381	$1,969	2016Q2	8.9%	$1,730	$415	$2,145
				24%										
	Project Operations			24%										
31	CONSTRUCTION MANAGEMENT													
6.0%	Construction Management	$4,579	$1,099	24%	$5,678	4.1%	$4,766	$1,144	$5,910	2016Q2	8.9%	$5,190	$1,246	$6,436
	Project Operation:			24%										
1.0%	Project Management	$763	$183	24%	$946	4.1%	$794	$191	$985	2016Q2	8.9%	$865	$208	$1,072
	CONTRACT COST TOTALS:	$90,058	$21,614		**$111,672**		$92,886	$22,293	$115,179			$96,887	$23,253	**$120,140**

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: NED - Freeport Harbor, Deepening and Selective Widening
LOCATION: Freeport, Texas
This Estimate reflects the scope and schedule in report; Project Feasibility Report

DISTRICT: Galveston District PREPARED: 3/30/2012
POC: CHIEF, COST ENGINEERING, Willie Joe Honza

Estimate Prepared: 30-Mar-12
Effective Price Level: 1-Oct-11

Program Year (Budget EC): 2014
Effective Price Level Date: 1 OCT 13

FULLY FUNDED PROJECT ESTIMATE

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	Contract #2 - Half of Outer Bar Ch & Jetty Ch													
12	NAVIGATION PORTS & HARBORS													
12	Hopper Dredge	$89,099	$21,384	24%	$110,483	3.0%	$91,746	$22,019	$113,765	2017Q2	5.9%	$97,155	$23,317	$120,473
12	Navigation Aids	$1,000	$240	24%	$1,240	3.0%	$1,030	$247	$1,277	2017Q2	5.9%	$1,090	$262	$1,352
	CONSTRUCTION ESTIMATE TOTALS:	$90,099	$21,624	24%	**$111,723**		$92,776	$22,266	$115,042			$98,246	$23,579	$121,825
01	LANDS AND DAMAGES													
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	$901	$216	24%	$1,117	4.1%	$938	$225	$1,163	2015Q2	4.8%	$983	$236	$1,219
1.0%	Planning & Environmental Compliance	$901	$216	24%	$1,117	4.1%	$938	$225	$1,163	2015Q2	4.8%	$983	$236	$1,219
5.0%	Engineering & Design	$4,505	$1,081	24%	$5,586	4.1%	$4,689	$1,125	$5,814	2015Q2	4.8%	$4,915	$1,180	$6,095
1.0%	Engineering Tech Review ITR & VE	$901	$216	24%	$1,117	4.1%	$938	$225	$1,163	2015Q2	4.8%	$983	$236	$1,219
1.0%	Contracting & Reprographics	$901	$216	24%	$1,117	4.1%	$938	$225	$1,163	2015Q2	4.8%	$983	$236	$1,219
	Real Estate In-House Labor			26%										
2.0%	Engineering During Construction	$1,802	$432	24%	$2,234	4.1%	$1,876	$450	$2,326	2017Q2	13.0%	$2,119	$509	$2,628
				24%										
	Project Operations			24%										
31	CONSTRUCTION MANAGEMENT													
6.0%	Construction Management	$5,406	$1,297	24%	$6,703	4.1%	$5,627	$1,350	$6,977	2017Q2	13.0%	$6,358	$1,526	$7,884
	Project Operation:			24%										
1.0%	Project Management	$901	$216	24%	$1,117	4.1%	$938	$225	$1,163	2017Q2	13.0%	$1,060	$254	$1,314
	CONTRACT COST TOTALS:	$106,317	$25,516		**$131,833**		$109,656	$26,317	$135,973			$116,630	$27,991	**$144,621**

****** TOTAL PROJECT COST SUMMARY ******

PROJECT: NED - Freeport Harbor, Deepening and Selective Widening
LOCATION: Freeport, Texas
This Estimate reflects the scope and schedule in report; Project Feasibility Report

DISTRICT: Galveston District PREPARED: 3/30/2012
POC: CHIEF, COST ENGINEERING, Willie Joe Honza

Estimate Prepared: 30-Mar-12
Effective Price Level: 1-Oct-11

Program Year (Budget EC): 2014
Effective Price Level Date: 1 OCT 13

FULLY FUNDED PROJECT ESTIMATE

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	Contract #3 -Lower TB													
12	NAVIGATION PORTS & HARBORS													
12	Non-Fed Costs	$9,488	$2,277	24%	$11,765	3.0%	$9,770	$2,345	$12,115	2015Q3	2.6%	$10,028	$2,407	$12,435
12	Federal Cost	$2,992	$718	24%	$3,710	3.0%	$3,081	$739	$3,820	2015Q3	2.6%	$3,162	$759	$3,921
	CONSTRUCTION ESTIMATE TOTALS:	$12,480	$2,995	24%	**$15,475**		$12,851	$3,084	$15,935			$13,191	$3,166	$16,356
01	LANDS AND DAMAGES	$63	$7	11%	$70	3.0%	$65	$7	$72	2015Q2	2.2%	$66	$7	$74
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	$125	$30	24%	$155	4.1%	$130	$31	$161	2015Q2	4.8%	$136	$33	$169
1.0%	Planning & Environmental Compliance	$125	$30	24%	$155	4.1%	$130	$31	$161	2015Q2	4.8%	$136	$33	$169
5.0%	Engineering & Design	$624	$150	24%	$774	4.1%	$649	$156	$805	2015Q2	4.8%	$681	$163	$844
1.0%	Engineering Tech Review ITR & VE	$125	$30	24%	$155	4.1%	$130	$31	$161	2015Q2	4.8%	$136	$33	$169
1.0%	Contracting & Reprographics	$125	$30	24%	$155	4.1%	$130	$31	$161	2015Q2	4.8%	$136	$33	$169
2.0%	Engineering During Construction	$250	$60	24%	$310	4.1%	$260	$62	$323	2015Q3	5.8%	$275	$66	$342
	Real Estate In-House Labor	$10	$2	20%	$12	4.1%	$10	$2	$12	2015Q3	5.8%	$11	$2	$13
	Project Operations			24%										
31	CONSTRUCTION MANAGEMENT													
6.0%	Construction Management	$749	$180	24%	$929	4.1%	$780	$187	$967	2015Q3	5.8%	$825	$198	$1,023
	Project Operation:			24%										
1.0%	Project Management	$125	$30	24%	$155	4.1%	$130	$31	$161	2015Q3	5.8%	$138	$33	$171
	CONTRACT COST TOTALS:	$14,801	$3,544		**$18,345**		$15,266	$3,655	$18,921			$15,733	$3,767	**$19,499**

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: NED - Freeport Harbor, Deepening and Selective Widening
LOCATION: Freeport, Texas
This Estimate reflects the scope and schedule in report; Project Feasibility Report

DISTRICT: Galveston District PREPARED: 3/30/2012
POC: CHIEF, COST ENGINEERING, Willie Joe Honza

Estimate Prepared: 30-Mar-12
Effective Price Level: 1-Oct-11

Program Year (Budget EC): 2014
Effective Price Level Date: 1 OCT 13

FULLY FUNDED PROJECT ESTIMATE

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	***B***	***C***	***D***	***E***	***F***	***G***	***H***	***I***	***J***	***P***	***L***	***M***	***N***	***O***
	Contract #4 - Real Estate for PA 8													
11	LEVEES & FLOODWALLS													
04	DAMS													
05	LOCKS													
06	FISH & WILDLIFE FACILITIES													
07	POWER PLANT													
	CONSTRUCTION ESTIMATE TOTALS:													
01	LANDS AND DAMAGES	$480	$48	10%	$528	3.0%	$494	$49	$544	2015Q1	1.7%	$503	$50	$553
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management													
1.0%	Planning & Environmental Compliance													
5.0%	Engineering & Design													
1.0%	Engineering Tech Review ITR & VE													
1.0%	Contracting & Reprographics													
	Real Estate In-House Labor	$10	$2	20%	$12	4.1%	$10	$2	$12	2015Q1	3.8%	$11	$2	$13
2.0%	Engineering During Construction													
	Project Operations													
31	CONSTRUCTION MANAGEMENT													
6.0%	Construction Management													
	Project Operation:													
1.0%	Project Management													
	CONTRACT COST TOTALS:	$490	$50		**$540**		$505	$52	$556			$514	$52	**$566**

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: NED - Freeport Harbor, Deepening and Selective Widening
LOCATION: Freeport, Texas
This Estimate reflects the scope and schedule in report; Project Feasibility Report

DISTRICT: Galveston District
POC: CHIEF, COST ENGINEERING, Willie Joe Honza
PREPARED: 3/30/2012

Estimate Prepared: 30-Mar-12
Effective Price Level: 1-Oct-11

Program Year (Budget EC): 2014
Effective Price Level Date: 1 OCT 13

FULLY FUNDED PROJECT ESTIMATE

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	Contract #5 - Dredge Ch to BRZPT through BRZPT TB													
12	NAVIGATION PORTS & HARBORS													
12	Non-Fed Costs	$16,428	$3,943	24%	$20,371	3.0%	$16,916	$4,060	$20,976	2016Q2	4.0%	$17,597	$4,223	$21,820
12	Federal Cost	$29,201	$7,008	24%	$36,209	3.0%	$30,069	$7,216	$37,285	2016Q2	4.0%	$31,278	$7,507	$38,785
	CONSTRUCTION ESTIMATE TOTALS:	$45,629	$10,951	24%	**$56,580**		$46,985	$11,276	$58,261			$48,875	$11,730	$60,605
01	LANDS AND DAMAGES	$28	$3	11%	$31	3.0%	$29	$3	$32	2015Q2	2.2%	$29	$3	$33
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	$456	$109	24%	$565	4.1%	$475	$114	$589	2015Q2	4.8%	$497	$119	$617
1.0%	Planning & Environmental Compliance	$456	$109	24%	$565	4.1%	$475	$114	$589	2015Q2	4.8%	$497	$119	$617
5.0%	Engineering & Design	$2,281	$547	24%	$2,828	4.1%	$2,374	$570	$2,944	2015Q2	4.8%	$2,489	$597	$3,086
1.0%	Engineering Tech Review ITR & VE	$456	$109	24%	$565	4.1%	$475	$114	$589	2015Q2	4.8%	$497	$119	$617
1.0%	Contracting & Reprographics	$456	$109	24%	$565	4.1%	$475	$114	$589	2015Q2	4.8%	$497	$119	$617
	Real Estate In-House Labor	$11	$2	18%	$13	4.1%	$11	$2	$14	2015Q2	4.8%	$12	$2	$14
2.0%	Engineering During Construction	$913	$219	24%	$1,132	4.1%	$950	$228	$1,178	2016Q2	8.9%	$1,035	$248	$1,283
	Project Operations													
31	CONSTRUCTION MANAGEMENT													
6.0%	Construction Management	$2,738	$657	24%	$3,395	4.1%	$2,850	$684	$3,534	2016Q2	8.9%	$3,104	$745	$3,848
	Project Operation:			24%										
1.0%	Project Management	$456	$109	24%	$565	4.1%	$475	$114	$589	2016Q2	8.9%	$517	$124	$641
	CONTRACT COST TOTALS:	$53,880	$12,927		**$66,807**		$55,572	$13,333	$68,905			$58,051	$13,928	**$71,978**

****** TOTAL PROJECT COST SUMMARY ******

PROJECT: NED - Freeport Harbor, Deepening and Selective Widening
LOCATION: Freeport, Texas
This Estimate reflects the scope and schedule in report; Project Feasibility Report

DISTRICT: Galveston District PREPARED: 3/30/2012
POC: CHIEF, COST ENGINEERING, Willie Joe Honza

Estimate Prepared: 30-Mar-12
Effective Price Level: 1-Oct-11

Program Year (Budget EC): 2014
Effective Price Level Date: 1 OCT 13

FULLY FUNDED PROJECT ESTIMATE

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	Contract #6 - Dredge Ch to Upper TB through Upper TB													
12	NAVIGATION PORTS & HARBORS													
12	Non-Fed Costs	$19,104	$4,585	24%	$23,689	3.0%	$19,672	$4,721	$24,393	2018Q1	7.3%	$21,111	$5,067	$26,177
12	Federal Cost	$11,083	$2,660	24%	$13,743	3.0%	$11,412	$2,739	$14,151	2018Q1	7.3%	$12,247	$2,939	$15,187
	CONSTRUCTION ESTIMATE TOTALS:	$30,187	$7,245	24%	**$37,432**		$31,084	$7,460	$38,544			$33,358	$8,006	$41,364
01	LANDS AND DAMAGES	$785	$79	10%	$864	3.0%	$808	$81	$890	2017Q2	5.9%	$856	$86	$942
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	$302	$72	24%	$374	4.1%	$314	$75	$390	2017Q2	13.0%	$355	$85	$440
1.0%	Planning & Environmental Compliance	$302	$72	24%	$374	4.1%	$314	$75	$390	2017Q2	13.0%	$355	$85	$440
5.0%	Engineering & Design	$1,509	$362	24%	$1,871	4.1%	$1,571	$377	$1,948	2017Q2	13.0%	$1,775	$426	$2,201
1.0%	Engineering Tech Review ITR & VE	$302	$72	24%	$374	4.1%	$314	$75	$390	2017Q2	13.0%	$355	$85	$440
1.0%	Contracting & Reprographics	$302	$72	24%	$374	4.1%	$314	$75	$390	2017Q2	13.0%	$355	$85	$440
	Real Estate In-House Labor	$27	$3	11%	$30	4.1%	$28	$3	$31	2017Q2	13.0%	$32	$4	$35
2.0%	Engineering During Construction	$604	$145	24%	$749	4.1%	$629	$151	$780	2018Q1	16.1%	$730	$175	$905
	Project Operations			24%										
31	CONSTRUCTION MANAGEMENT													
6.0%	Construction Management	$1,811	$435	24%	$2,246	4.1%	$1,885	$452	$2,337	2018Q1	16.1%	$2,188	$525	$2,713
	Project Operation:			24%										
1.0%	Project Management	$302	$72	24%	$374	4.1%	$314	$75	$390	2018Q1	16.1%	$365	$88	$452
	CONTRACT COST TOTALS:	$36,433	$8,631		**$45,064**		$37,576	$8,902	$46,478			$40,723	$9,650	**$50,373**

****** TOTAL PROJECT COST SUMMARY ******

****** CONTRACT COST SUMMARY ******

PROJECT: NED - Freeport Harbor, Deepening and Selective Widening
LOCATION: Freeport, Texas
This Estimate reflects the scope and schedule in report; Project Feasibility Report

DISTRICT: Galveston District PREPARED: 3/30/2012
POC: CHIEF, COST ENGINEERING, Willie Joe Honza

Estimate Prepared: 30-Mar-12
Effective Price Level: 1-Oct-11

Program Year (Budget EC): 2014
Effective Price Level Date: 1 OCT 13

FULLY FUNDED PROJECT ESTIMATE

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	Contract #7 -Dredge Stauffer Ch													
12	NAVIGATION PORTS & HARBORS													
12	Non-Fed Costs	$1,092	$262	24%	$1,354	3.0%	$1,124	$270	$1,394	2018Q4	8.8%	$1,223	$294	$1,517
12	Lower Stauffer Ch	$7,612	$1,827	24%	$9,439	3.0%	$7,838	$1,881	$9,719	2018Q4	8.8%	$8,526	$2,046	$10,572
12	Upper Stauffer Ch	$2,525	$606	24%	$3,131	3.0%	$2,600	$624	$3,224	2018Q4	8.8%	$2,828	$679	$3,507
	CONSTRUCTION ESTIMATE TOTALS:	$11,229	$2,695	24%	**$13,924**		$11,563	$2,775	$14,338			$12,577	$3,019	$15,596
01	LANDS AND DAMAGES	$135	$25	19%	$160	3.0%	$139	$26	$165	2018Q3	8.3%	$151	$28	$178
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	$112	$27	24%	$139	4.1%	$117	$28	$145	2018Q3	18.1%	$138	$33	$171
1.0%	Planning & Environmental Compliance	$112	$27	24%	$139	4.1%	$117	$28	$145	2018Q3	18.1%	$138	$33	$171
5.0%	Engineering & Design	$561	$135	24%	$696	4.1%	$584	$140	$724	2018Q3	18.1%	$690	$166	$855
1.0%	Engineering Tech Review ITR & VE	$112	$27	24%	$139	4.1%	$117	$28	$145	2018Q3	18.1%	$138	$33	$171
1.0%	Contracting & Reprographics	$112	$27	24%	$139	4.1%	$117	$28	$145	2018Q3	18.1%	$138	$33	$171
	Real Estate In-House Labor	$115	$50	43%	$165	4.1%	$120	$52	$172	2018Q3	18.1%	$141	$61	$203
2.0%	Engineering During Construction	$225	$54	24%	$279	4.1%	$234	$56	$290	2018Q4	19.1%	$279	$67	$346
	Project Operations			24%										
31	CONSTRUCTION MANAGEMENT													
6.0%	Construction Management	$674	$162	24%	$836	4.1%	$702	$168	$870	2018Q4	19.1%	$836	$201	$1,036
	Project Operation:			24%										
1.0%	Project Management	$112	$27	24%	$139	4.1%	$117	$28	$145	2018Q4	19.1%	$139	$33	$172
	CONTRACT COST TOTALS:	$13,499	$3,255		**$16,754**		$13,924	$3,357	$17,281			$15,363	$3,706	**$19,069**

****** TOTAL PROJECT COST SUMMARY ******

****** CONTRACT COST SUMMARY ******

PROJECT: NED - Freeport Harbor, Deepening and Selective Widening
LOCATION: Freeport, Texas
This Estimate reflects the scope and schedule in report; Project Feasibility Report

DISTRICT: Galveston District PREPARED: 3/30/2012
POC: CHIEF, COST ENGINEERING, Willie Joe Honza

Estimate Prepared: 30-Mar-12
Effective Price Level: 1-Oct-11

Program Year (Budget EC): 2014
Effective Price Level Date: 1 OCT 13

FULLY FUNDED PROJECT ESTIMATE

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	Contract #8 - PA Mitigation													
06	FISH & WILDLIFE FACILITIES	$130	$31	24%	$ 161	3.0%	$134	$32	$166	2018Q3	8.3%	$145	$35	$180
	CONSTRUCTION ESTIMATE TOTALS:	$130	$31	24%	**161**		$134	$32	$166			$145	$35	$180
01	LANDS AND DAMAGES													
30	PLANNING, ENGINEERING & DESIGN													
5.0%	Project Management	$7	$2	24%	9	4.1%	$7	$2	$9	2018Q1	16.1%	$8	$2	$10
5.0%	Planning & Environmental Compliance	$7	$2	24%	9	4.1%	$7	$2	$9	2018Q1	16.1%	$8	$2	$10
20.0%	Engineering & Design	$26	$6	24%	32	4.1%	$27	$6	$34	2018Q1	16.1%	$31	$8	$39
5.0%	Engineering Tech Review ITR & VE	$7	$2	24%	9	4.1%	$7	$2	$9	2018Q1	16.1%	$8	$2	$10
5.0%	Contracting & Reprographics	$7	$2	24%	9	4.1%	$7	$2	$9	2018Q1	16.1%	$8	$2	$10
5.0%	Engineering During Construction	$7	$2	24%	9	4.1%	$7	$2	$9	2018Q3	18.1%	$9	$2	$11
	Real Estate In-House Labor													
	Project Operations													
31	CONSTRUCTION MANAGEMENT													
10.0%	Construction Management	$13	$3	24%	16	4.1%	$14	$3	$17	2018Q3	18.1%	$16	$4	$20
5.0%	Project Management	$7	$2	24%	9	4.1%	$7	$2	$9	2018Q3	18.1%	$9	$2	$11
	CONTRACT COST TOTALS:	$211	$51		**262**		$218	$52	$271			$243	$58	**$302**

**** TOTAL PROJECT COST SUMMARY ****

PROJECT: LPP - Freeport Harbor, Deepening and Selective Widening
LOCATION: Freeport, Texas

DISTRICT: Galveston District PREPARED: 3/30/2012
POC: CHIEF, COST ENGINEERING, Willie Joe Honza

This Estimate reflects the scope and schedule in report; Project Feasibility Report

Program Year (Budget EC): 2014
Effective Price Level Date: 1 OCT 13

WBS NUMBER	Civil Works Feature & Sub-Feature Description	ESTIMATED COST COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	PROJECT FIRST COST ESC (%)	COST ($K)	CNTG ($K)	**TOTAL ($K)**	TOTAL PROJECT COST (FULLY FUNDED) Spent Thru: 31-Mar-12 ($K)		COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*K*	*L*	*M*	*N*	*O*
12	NAVIGATION PORTS & HARBORS			-		-								
12	Non- Federal	$46,112	$11,067	24%	$57,179	3.0%	$47,482	$11,396	**$58,878**			$49,862	$11,967	$61,829
12	Federal	$165,113	$39,627	24%	$204,740	3.0%	$170,019	$40,805	**$210,823**			$178,086	$42,741	$220,826
06	FISH & WILDLIFE FACILITIES	$130	$31	24%	$161	3.0%	$134	$32	**$166**			$145	$35	$180
	CONSTRUCTION ESTIMATE TOTALS:	$211,355	$50,725		**$262,080**	3.0%	$217,635	$52,232	**$269,867**			$228,093	$54,742	$282,835
01	LANDS AND DAMAGES	$1,491	$162	11%	$1,653	3.0%	$1,535	$167	**$1,702**			$1,581	$172	$1,753
30	PROJECT EXPENDITURES													
	Non-Federal Cost									4,050				$4,050
	Federal Cost									4,050				$4,050
30	PLANNING, ENGINEERING & DESIGN	$14,281	$3,445	24%	$17,726	4.1%	$14,864	$3,585	**$18,449**			$15,793	$3,812	$19,606
31	CONSTRUCTION MANAGEMENT	$7,413	$1,779	24%	$9,192	4.1%	$7,715	$1,852	**$9,567**			$8,544	$2,051	$10,595
	PROJECT COST TOTALS:	$234,540	$56,111	24%	**$290,651**	3.1%	$241,749	$57,836	**$299,586**	8,100		$254,011	$60,777	$322,888

______________________ CHIEF, COST ENGINEERING, Willie Joe Honza

______________________ PROJECT MANAGER, Sharon Tirpak

______________________ CHIEF, REAL ESTATE, Orlando Rosa

______________________ CHIEF, PLANNING, Dolan Dunn

______________________ CHIEF, ENGINEERING, Robert Howell

______________________ CHIEF, OPERATIONS, Joe Hrametz

______________________ CHIEF, CONSTRUCTION, Don Carelock

______________________ CHIEF, CONTRACTING, John Eugino

______________________ CHIEF, PM-J, Valerie Miller

______________________ CHIEF, DPM, Pete Perez

ESTIMATED FEDERAL COST: **$255,256**
ESTIMATED NON-FEDERAL COST: **$67,632**

ESTIMATED TOTAL PROJECT COST: $322,888

****** TOTAL PROJECT COST SUMMARY ******

****** CONTRACT COST SUMMARY ******

PROJECT: LPP - Freeport Harbor, Deepening and Selective Widening
LOCATION: Freeport, Texas
This Estimate reflects the scope and schedule in report; Project Feasibility Report

DISTRICT: Galveston District PREPARED: 3/30/2012
POC: CHIEF, COST ENGINEERING, Willie Joe Honza

	Estimate Prepared:	30-Mar-12				Program Year (Budget EC):			2014					
	Effective Price Level:	1-Oct-11				Effective Price Level Date:			1 OCT 13	FULLY FUNDED PROJECT ESTIMATE				
				RISK BASED										
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	Cont #1 - Future Ch Ext &Half of Outer Bar Ch													
12	NAVIGATION PORTS & HARBORS													
12	Hopper Dredge	$45,415	$10,900	24%	$56,315	3.0%	$46,764	$11,223	$57,988	2015Q4	3.1%	$48,217	$11,572	$59,789
12	Navigation Aids	$90	$22	24%	$112	3.0%	$93	$22	$115	2015Q4	3.1%	$96	$23	$118
	CONSTRUCTION ESTIMATE TOTALS:	$45,505	$10,921	24%	**$56,426**		$46,857	$11,246	$58,103			$48,312	$11,595	$59,907
01	LANDS AND DAMAGES													
30	PLANNING, ENGINEERING & DESIGN													
0.5%	Project Management	$228	$55	24%	$283	4.1%	$237	$57	$294	2014Q4	2.8%	$244	$59	$303
0.8%	Planning & Environmental Compliance	$364	$87	24%	$451	4.1%	$379	$91	$470	2014Q4	2.8%	$390	$93	$483
3.0%	Engineering & Design	$1,365	$328	24%	$1,693	4.1%	$1,421	$341	$1,762	2014Q4	2.8%	$1,461	$351	$1,811
0.8%	Engineering Tech Review ITR & VE	$341	$82	24%	$423	4.1%	$355	$85	$440	2014Q4	2.8%	$365	$88	$453
0.8%	Contracting & Reprographics	$364	$87	24%	$451	4.1%	$379	$91	$470	2014Q4	2.8%	$390	$93	$483
0.8%	Engineering During Construction	$364	$87	24%	$451	4.1%	$379	$91	$470	2015Q4	6.9%	$405	$97	$502
	Real Estate In-House Labor			24%										
	Project Operations			24%										
31	CONSTRUCTION MANAGEMENT													
3.0%	Construction Management	$1,365	$328	24%	$1,693	4.1%	$1,421	$341	$1,762	2015Q4	6.9%	$1,518	$364	$1,883
	Project Operation:			24%										
0.5%	Project Management	$228	$55	24%	$283	4.1%	$237	$57	$294	2015Q4	6.9%	$254	$61	$314
	CONTRACT COST TOTALS:	$50,124	$12,030		**$62,154**		$51,665	$12,399	$64,064			$53,338	$12,801	**$66,139**

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: LPP - Freeport Harbor, Deepening and Selective Widening
LOCATION: Freeport, Texas
This Estimate reflects the scope and schedule in report; Project Feasibility Report

DISTRICT: Galveston District PREPARED: 3/30/2012
POC: CHIEF, COST ENGINEERING, Willie Joe Honza

	Estimate Prepared:	30-Mar-12				Program Year (Budget EC):			2014					
	Effective Price Level:	1-Oct-11				Effective Price Level Date:			1 OCT 13	FULLY FUNDED PROJECT ESTIMATE				
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	Contract #2 - Half of Outer Bar Ch & Jetty Ch													
12	NAVIGATION PORTS & HARBORS													
12	Hopper Dredge	$72,311	$17,355	24%	$89,666	3.0%	$74,460	$17,870	$92,330	2017Q1	5.4%	$78,494	$18,839	$97,332
12	Navigation Aids	$1,000	$240	24%	$1,240	3.0%	$1,030	$247	$1,277	2017Q1	5.4%	$1,086	$261	$1,346
	CONSTRUCTION ESTIMATE TOTALS:	$73,311	$17,595	24%	**$90,906**		$75,489	$18,117	$93,607			$79,579	$19,099	$98,678
01	LANDS AND DAMAGES													
30	PLANNING, ENGINEERING & DESIGN													
0.5%	Project Management	$367	$88	24%	$455	4.1%	$382	$92	$474	2015Q2	4.8%	$400	$96	$496
0.8%	Planning & Environmental Compliance	$586	$141	24%	$727	4.1%	$610	$146	$756	2015Q2	4.8%	$639	$153	$793
3.0%	Engineering & Design	$2,199	$528	24%	$2,727	4.1%	$2,289	$549	$2,838	2015Q2	4.8%	$2,399	$576	$2,975
0.8%	Engineering Tech Review ITR & VE	$550	$132	24%	$682	4.1%	$572	$137	$710	2015Q2	4.8%	$600	$144	$744
0.8%	Contracting & Reprographics	$586	$141	24%	$727	4.1%	$610	$146	$756	2015Q2	4.8%	$639	$153	$793
0.8%	Engineering During Construction	$586	$141	24%	$727	4.1%	$610	$146	$756	2017Q1	12.0%	$683	$164	$847
	Real Estate In-House Labor													
	Project Operations			24%										
31	CONSTRUCTION MANAGEMENT													
3.0%	Construction Management	$2,199	$528	24%	$2,727	4.1%	$2,289	$549	$2,838	2017Q1	12.0%	$2,563	$615	$3,178
	Project Operation:			24%										
0.5%	Project Management	$367	$88	24%	$455	4.1%	$382	$92	$474	2017Q1	12.0%	$428	$103	$530
	CONTRACT COST TOTALS:	$80,751	$19,380		**$100,131**		$83,233	$19,976	$103,209			$87,931	$21,103	**$109,034**

****** TOTAL PROJECT COST SUMMARY ******

PROJECT: LPP - Freeport Harbor, Deepening and Selective Widening
LOCATION: Freeport, Texas
This Estimate reflects the scope and schedule in report; Project Feasibility Report

DISTRICT: Galveston District PREPARED: 3/30/2012
POC: CHIEF, COST ENGINEERING, Willie Joe Honza

		Estimate Prepared: 30-Mar-12				Program Year (Budget EC): 2014				FULLY FUNDED PROJECT ESTIMATE				
		Effective Price Level: 1-Oct-11				Effective Price Level Date: 1 OCT 13								
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	Contract #3 -Lower TB													
12	NAVIGATION PORTS & HARBORS													
12	Non-Fed Costs	$9,488	$2,277	24%	$11,765	3.0%	$9,770	$2,345	$12,115	2015Q3	2.6%	$10,028	$2,407	$12,435
12	Federal Cost	$2,325	$558	24%	$2,883	3.0%	$2,394	$575	$2,969	2015Q3	2.6%	$2,457	$590	$3,047
	CONSTRUCTION ESTIMATE TOTALS:	$11,813	$2,835	24%	**$14,648**		$12,164	$2,919	$15,083			$12,486	$2,997	$15,482
01	LANDS AND DAMAGES	$63	$7	11%	$70	3.0%	$65	$7	$72	2015Q2	2.2%	$66	$7	$74
30	PLANNING, ENGINEERING & DESIGN													
0.5%	Project Management	$59	$14	24%	$73	4.1%	$61	$15	$76	2015Q2	4.8%	$64	$15	$80
0.8%	Planning & Environmental Compliance	$95	$23	24%	$118	4.1%	$99	$24	$123	2015Q2	4.8%	$104	$25	$129
3.0%	Engineering & Design	$354	$85	24%	$439	4.1%	$368	$88	$457	2015Q2	4.8%	$386	$93	$479
0.8%	Engineering Tech Review ITR & VE	$89	$21	24%	$110	4.1%	$93	$22	$115	2015Q2	4.8%	$97	$23	$120
0.8%	Contracting & Reprographics	$95	$23	24%	$118	4.1%	$99	$24	$123	2015Q2	4.8%	$104	$25	$129
0.8%	Engineering During Construction	$95	$23	24%	$118	4.1%	$99	$24	$123	2015Q3	5.8%	$105	$25	$130
	Real Estate In-House Labor	$10	$2	20%	$12	4.1%	$10	$2	$12	2015Q3	5.8%	$11	$2	$13
	Project Operations			24%										
31	CONSTRUCTION MANAGEMENT													
3.0%	Construction Management	$354	$85	24%	$439	4.1%	$368	$88	$457	2015Q3	5.8%	$390	$94	$484
0.5%	Project Management	$59	$14	24%	$73	4.1%	$61	$15	$76	2015Q3	5.8%	$65	$16	$81
	CONTRACT COST TOTALS:	$13,086	$3,132		**$16,218**		$13,488	$3,228	$16,717			$13,878	$3,322	**$17,199**

****** TOTAL PROJECT COST SUMMARY ******

****** CONTRACT COST SUMMARY ******

PROJECT: LPP - Freeport Harbor, Deepening and Selective Widening
LOCATION: Freeport, Texas
This Estimate reflects the scope and schedule in report; Project Feasibility Report

DISTRICT: Galveston District PREPARED: 3/30/2012
POC: CHIEF, COST ENGINEERING, Willie Joe Honza

Estimate Prepared: 30-Mar-12
Effective Price Level: 1-Oct-11

Program Year (Budget EC): 2014
Effective Price Level Date: 1 OCT 13

FULLY FUNDED PROJECT ESTIMATE

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	Contract #4 - Real Estate PA 8													
11	LEVEES & FLOODWALLS													
04	DAMS													
05	LOCKS													
06	FISH & WILDLIFE FACILITIES													
07	POWER PLANT													
	CONSTRUCTION ESTIMATE TOTALS:													
01	LANDS AND DAMAGES	$480	$48	10%	$528	3.0%	$494	$49	$544	2014Q1		$494	$49	$544
30	PLANNING, ENGINEERING & DESIGN													
0.5%	Project Management													
0.8%	Planning & Environmental Compliance													
3.0%	Engineering & Design													
0.8%	Engineering Tech Review ITR & VE													
0.8%	Contracting & Reprographics													
0.8%	Real Estate In-House Labor	$10	$2	20%	$12	4.1%	$10	$2	$12	2014Q1		$10	$2	$12
0.8%	Engineering During Construction													
	Project Operations													
31	CONSTRUCTION MANAGEMENT													
3.0%	Construction Management													
	Project Operation:													
0.5%	Project Management													
	CONTRACT COST TOTALS:	$490	$50		**$540**		$505	$52	$556			$505	$52	**$556**

****** TOTAL PROJECT COST SUMMARY ******

****** CONTRACT COST SUMMARY ******

PROJECT: LPP - Freeport Harbor, Deepening and Selective Widening
LOCATION: Freeport, Texas
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DISTRICT: Galveston District PREPARED: 3/30/2012
POC: CHIEF, COST ENGINEERING, Willie Joe Honza

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Program Year (Budget EC): 2014
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FULLY FUNDED PROJECT ESTIMATE

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	Contract #5 - Dredge Ch to BRZPT through BRZPT TB													
12	NAVIGATION PORTS & HARBORS													
12	Non-Fed Costs	$16,428	$3,943	24%	$20,371	3.0%	$16,916	$4,060	$20,976	2016Q2	4.0%	$17,597	$4,223	$21,820
12	Federal Cost	$23,039	$5,529	24%	$28,568	3.0%	$23,724	$5,694	$29,417	2016Q2	4.0%	$24,678	$5,923	$30,601
	CONSTRUCTION ESTIMATE TOTALS:	$39,467	$9,472	24%	**$48,939**		$40,640	$9,754	$50,393			$42,275	$10,146	$52,421
01	LANDS AND DAMAGES	$28	$3	11%	$31	3.0%	$29	$3	$32	2015Q2	2.2%	$29	$3	$33
30	PLANNING, ENGINEERING & DESIGN													
0.5%	Project Management	$197	$47	24%	$244	4.1%	$205	$49	$254	2015Q2	4.8%	$215	$52	$267
0.8%	Planning & Environmental Compliance	$316	$76	24%	$392	4.1%	$329	$79	$408	2015Q2	4.8%	$345	$83	$427
3.0%	Engineering & Design	$1,184	$284	24%	$1,468	4.1%	$1,232	$296	$1,528	2015Q2	4.8%	$1,292	$310	$1,602
0.8%	Engineering Tech Review ITR & VE	$296	$71	24%	$367	4.1%	$308	$74	$382	2015Q2	4.8%	$323	$78	$400
0.8%	Contracting & Reprographics	$316	$76	24%	$392	4.1%	$329	$79	$408	2015Q2	4.8%	$345	$83	$427
0.8%	Engineering During Construction	$316	$76	24%	$392	4.1%	$329	$79	$408	2016Q2	8.9%	$358	$86	$444
	Real Estate In-House Labor	$11	$2	18%	$13	4.1%	$11	$2	$14	2016Q2	8.9%	$12	$2	$15
	Project Operations													
31	CONSTRUCTION MANAGEMENT													
3.0%	Construction Management	$1,184	$284	24%	$1,468	4.1%	$1,232	$296	$1,528	2016Q2	8.9%	$1,342	$322	$1,664
0.5%	Project Management	$197	$47	24%	$244	4.1%	$205	$49	$254	2016Q2	8.9%	$223	$54	$277
	CONTRACT COST TOTALS:	$43,512	$10,439		**$53,951**		$44,849	$10,759	$55,609			$46,759	$11,218	**$57,977**

**** TOTAL PROJECT COST SUMMARY ****

PROJECT: LPP - Freeport Harbor, Deepening and Selective Widening
LOCATION: Freeport, Texas
This Estimate reflects the scope and schedule in report; Project Feasibility Report

DISTRICT: Galveston District PREPARED: 3/30/2012
POC: CHIEF, COST ENGINEERING, Willie Joe Honza

Estimate Prepared: 30-Mar-12
Effective Price Level: 1-Oct-11

Program Year (Budget EC): 2014
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FULLY FUNDED PROJECT ESTIMATE

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	Contract #6 - Dredge Ch to Upper TB through Upper TB													
12	NAVIGATION PORTS & HARBORS													
12	Non-Fed Costs	$19,104	$4,585	24%	$23,689	3.0%	$19,672	$4,721	$24,393	2017Q4	6.9%	$21,019	$5,045	$26,064
12	Federal Cost	$10,796	$2,591	24%	$13,387	3.0%	$11,117	$2,668	$13,785	2017Q4	6.9%	$11,878	$2,851	$14,729
	CONSTRUCTION ESTIMATE TOTALS:	$29,900	$7,176	24%	**$37,076**		$30,788	$7,389	$38,178			$32,898	$7,895	$40,793
01	LANDS AND DAMAGES	$785	$79	10%	$864	3.0%	$808	$81	$890	2016Q3	4.5%	$845	$85	$930
30	PLANNING, ENGINEERING & DESIGN													
0.5%	Project Management	$150	$36	24%	$186	4.1%	$156	$37	$194	2016Q3	9.9%	$172	$41	$213
0.8%	Planning & Environmental Compliance	$239	$57	24%	$296	4.1%	$249	$60	$308	2016Q3	9.9%	$273	$66	$339
3.0%	Engineering & Design	$897	$215	24%	$1,112	4.1%	$934	$224	$1,158	2016Q3	9.9%	$1,026	$246	$1,273
0.8%	Engineering Tech Review ITR & VE	$224	$54	24%	$278	4.1%	$233	$56	$289	2016Q3	9.9%	$256	$62	$318
0.8%	Contracting & Reprographics	$239	$57	24%	$296	4.1%	$249	$60	$308	2016Q3	9.9%	$273	$66	$339
	Real Estate In-House Labor	$27	$3	11%	$30	4.1%	$28	$3	$31	2016Q3	9.9%	$31	$3	$34
0.8%	Engineering During Construction	$239	$57	24%	$296	4.1%	$249	$60	$308	2017Q4	15.0%	$286	$69	$355
											15.0%			
	Project Operations													
31	CONSTRUCTION MANAGEMENT													
3.0%	Construction Management	$897	$215	24%	$1,112	4.1%	$934	$224	$1,158	2017Q4	15.0%	$1,074	$258	$1,332
0.5%	Project Management	$150	$36	24%	$186	4.1%	$156	$37	$194	2017Q4	15.0%	$180	$43	$223
	CONTRACT COST TOTALS:	$33,747	$7,986		**$41,733**		$34,784	$8,232	$43,015			$37,314	$8,834	**$46,148**

****** TOTAL PROJECT COST SUMMARY ******

****** CONTRACT COST SUMMARY ******

PROJECT: LPP - Freeport Harbor, Deepening and Selective Widening
LOCATION: Freeport, Texas
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DISTRICT: Galveston District
POC: CHIEF, COST ENGINEERING, Willie Joe Honza
PREPARED: 3/30/2012

Estimate Prepared: 30-Mar-12
Effective Price Level: 1-Oct-11

Program Year (Budget EC): 2014
Effective Price Level Date: 1 OCT 13

FULLY FUNDED PROJECT ESTIMATE

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	Contract #7 -Dredge Stauffer Ch													
12	NAVIGATION PORTS & HARBORS													
12	Non-Fed Costs	$1,092	$262	24%	$1,354	3.0%	$1,124	$270	$1,394	2018Q3	8.3%	$1,218	$292	$1,510
12	Lower Stauffer Ch	$7,612	$1,827	24%	$9,439	3.0%	$7,838	$1,881	$9,719	2018Q3	8.3%	$8,488	$2,037	$10,525
12	Upper Stauffer Ch	$2,525	$606	24%	$3,131	3.0%	$2,600	$624	$3,224	2016Q1	3.6%	$2,692	$646	$3,339
	CONSTRUCTION ESTIMATE TOTALS:	$11,229	$2,695	24%	**$13,924**		$11,563	$2,775	$14,338			$12,398	$2,975	$15,373
01	LANDS AND DAMAGES	$135	$25	19%	$160	3.0%	$139	$26	$165	2017Q1	5.4%	$147	$27	$174
30	PLANNING, ENGINEERING & DESIGN													
0.5%	Project Management	$56	$13	24%	$69	4.1%	$58	$14	$72	2017Q1	12.0%	$65	$16	$81
0.8%	Planning & Environmental Compliance	$90	$22	24%	$112	4.1%	$94	$22	$116	2017Q1	12.0%	$105	$25	$130
3.0%	Engineering & Design	$337	$81	24%	$418	4.1%	$351	$84	$435	2017Q1	12.0%	$393	$94	$487
0.8%	Engineering Tech Review ITR & VE	$84	$20	24%	$104	4.1%	$87	$21	$108	2017Q1	12.0%	$98	$23	$121
0.8%	Contracting & Reprographics	$90	$22	24%	$112	4.1%	$94	$22	$116	2017Q1	12.0%	$105	$25	$130
	Real Estate In-House Labor	$115	$50	43%	$165	4.1%	$120	$52	$172	2017Q1	18.1%	$141	$61	$203
0.8%	Engineering During Construction	$90	$22	24%	$112	4.1%	$94	$22	$116	2018Q3	18.1%	$111	$27	$137
31	CONSTRUCTION MANAGEMENT													
3.0%	Construction Management	$337	$81	24%	$418	4.1%	$351	$84	$435	2018Q3	18.1%	$414	$99	$514
0.5%	Project Management	$56	$13	24%	$69	4.1%	$58	$14	$72	2018Q3	18.1%	$69	$17	$85
	CONTRACT COST TOTALS:	$12,619	$3,044		**$15,663**		$13,008	$3,138	$16,145			$14,045	$3,390	**$17,436**

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: LPP - Freeport Harbor, Deepening and Selective Widening
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DISTRICT: Galveston District PREPARED: 3/30/2012
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FULLY FUNDED PROJECT ESTIMATE

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	Contract #8 - PA Mitigation													
06	FISH & WILDLIFE FACILITIES	$130	$31	24%	$ 161	3.0%	$134	$32	$166	2018Q3	8.3%	$145	$35	$180
	CONSTRUCTION ESTIMATE TOTALS:	$130	$31	24%	**161**		$134	$32	$166			$145	$35	$180
01	LANDS AND DAMAGES													
30	PLANNING, ENGINEERING & DESIGN													
5.0%	Project Management	$7	$2	24%	9	4.1%	$7	$2	$9	2017Q1	12.0%	$8	$2	$10
5.0%	Planning & Environmental Compliance	$7	$2	24%	9	4.1%	$7	$2	$9	2017Q1	12.0%	$8	$2	$10
20.0%	Engineering & Design	$26	$6	24%	32	4.1%	$27	$6	$34	2017Q1	12.0%	$30	$7	$38
5.0%	Engineering Tech Review ITR & VE	$7	$2	24%	9	4.1%	$7	$2	$9	2017Q1	12.0%	$8	$2	$10
	Real Estate In-House Labor													
5.0%	Contracting & Reprographics	$7	$2	24%	9	4.1%	$7	$2	$9	2017Q1	12.0%	$8	$2	$10
5.0%	Engineering During Construction	$7	$2	24%	9	4.1%	$7	$2	$9	2018Q3	18.1%	$9	$2	$11
31	CONSTRUCTION MANAGEMENT													
10.0%	Construction Management	$13	$3	24%	16	4.1%	$14	$3	$17	2018Q3	18.1%	$16	$4	$20
	Project Operation:			24%										
5.0%	Project Management	$7	$2	24%	9	4.1%	$7	$2	$9	2018Q3	18.1%	$9	$2	$11
	CONTRACT COST TOTALS:	$211	$51		**262**		$218	$52	$271			$241	$58	**$299**