3.0 AFFECTED ENVIRONMENT

For the purposes of analysis in this EIS, unless otherwise defined, the project area is defined as the footprint of the construction area within the channel plus a 1-mile buffer area and the PAs (Figure 3.0-1). Because impacts may affect resources outside of this project area, unless otherwise noted, the study area consists of all of Brazoria County (Figure 3.0-2). If the project or study area differs from this for a specific resource, it will be defined in that section.

3.1 AIR QUALITY

Brazoria County is part of the Houston-Galveston Air Quality Control Region, also referred to as the Houston-Galveston Area (HGA). The HGA includes Harris County and the seven surrounding counties of Montgomery, Liberty, Chambers, Galveston, Brazoria, Fort Bend, and Waller. Existing air quality conditions for the HGA were used as a baseline for comparison because air quality impacts generally are more regional than localized. Therefore, the Project Area for Air Quality purposes is defined as the HGA, unless otherwise noted.

3.1.1 Regulatory Context

The Clean Air Act (CAA) of 1970, 42 United States Code (USC) 7401 et seq. amended in 1977 and 1990 and Title 40 Code of Federal Regulations (40 CFR) Parts 50–99, are the basic Federal statutes and regulations governing air pollution. The provisions that are potentially relevant to this project are the National Ambient Air Quality Standards (NAAQS) and the General Conformity Rules promulgated by the EPA and incorporated into corresponding state rules by the TCEQ.

3.1.1.1 National Ambient Air Quality Standards

The CAA requires the EPA to establish NAAQS for pollutants considered harmful to public health and the environment. Primary standards set limits to protect public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly. Secondary standards set limits to protect public welfare, including protection against decreased visibility, damage to animals, crops, vegetation, and buildings.

The EPA has established NAAQS for six principal pollutants, which are called "criteria" pollutants. They are carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), lead (Pb), particulate matter with particle diameters of 10 microns or less (PM_{10}), particulate matter with diameters of 2.5 microns or less ($PM_{2.5}$), and sulfur dioxide (SO_2). The NAAQS are codified in 40 CFR Part 50 and are summarized in Table 3.1-1.

CO is a colorless, odorless, tasteless gas. It may temporarily accumulate at harmful levels, especially in calm weather during winter and early spring, when fuel combustion reaches a peak and CO is chemically more stable due to the low temperatures. CO usually dissipates quickly over a large area, posing minimal

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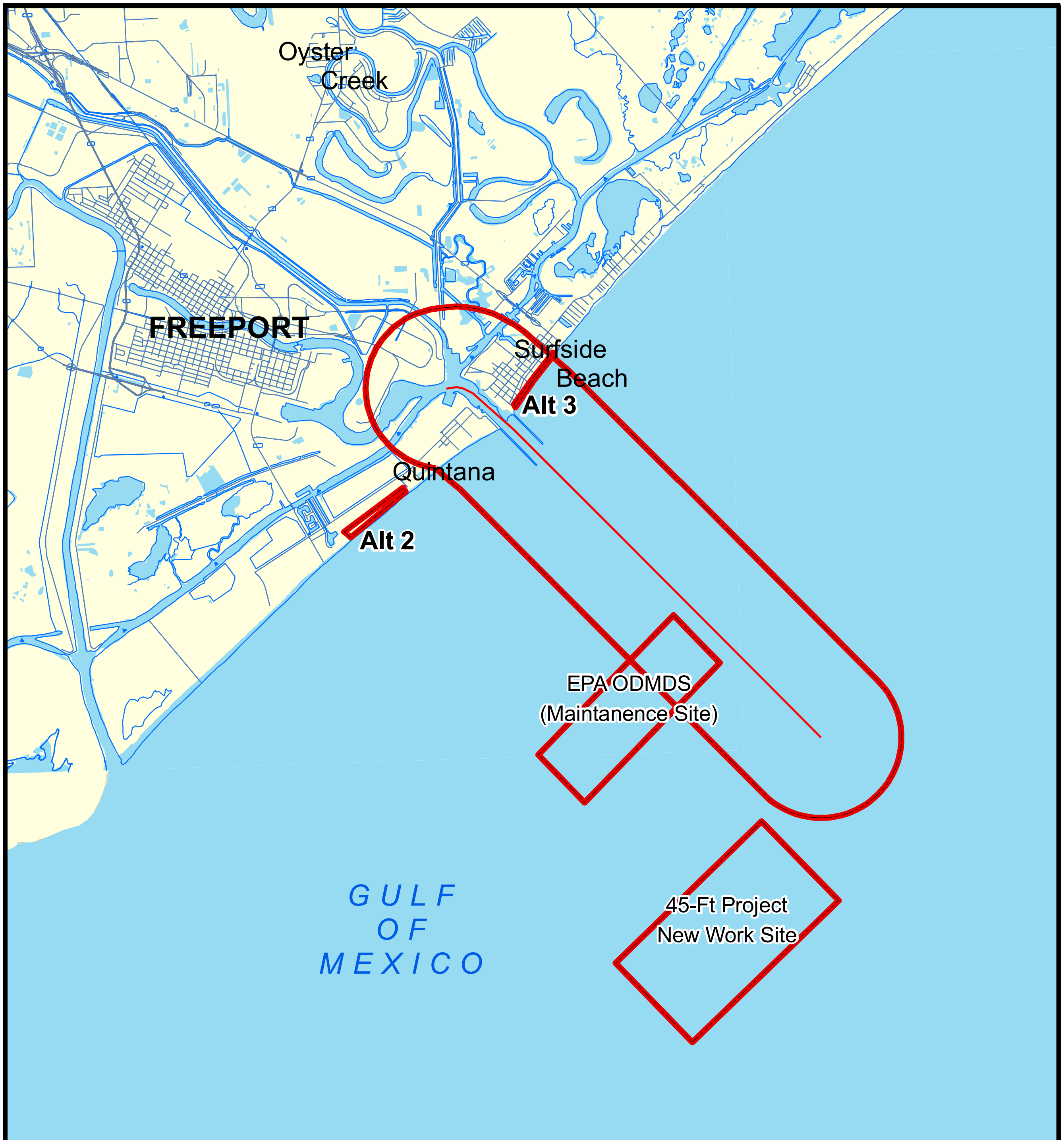
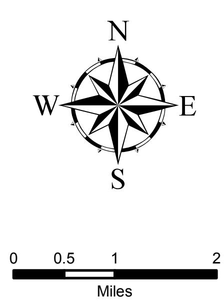


Legend

- Channel Centerline
- Project Area Components



PBSJ
6504 Bridge Point Pkwy, Ste. 200
Austin, Texas 78730
Phone: (512) 329-8342 Fax: (512) 327-2453

Figure 3.0-1
Port Freeport Channel Widening Project Area

Prepared for: Martin Arhelger
Job No.: 441591
Prepared by: TBrown/A Pugh
Date: 08/30/2006
File: N:/44159100/Projects/Project_Area.mxd

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Legend

← Freeport Channel Widening Project Area

Study Area

N
W E
S

10 5 0 10 Miles

PBS&J
6504 Bridge Point Pkwy, Ste. 200
Austin, Texas 78730
Phone: (512) 329-8342 Fax: (512) 327-2453

Figure 3.0-2
Port Freeport Channel Widening Study Area

Prepared for: Martin Arhelger	
Job No.: 441591	
Prepared by: Emons	Date: 08/23/2006
File: N:/44159100/Projects/Study_Area.mxd	

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threat to human health. Transportation activities, indoor heating, and open burning are among the anthropogenic (man-made) sources of CO.

TABLE 3.1-1

NATIONAL AMBIENT AIR QUALITY STANDARDS FOR THE PROJECT AREA

Pollutant	Averaging Time	Primary Standard	Secondary Standard
Carbon Monoxide (CO)	1-Hour[a]	35 ppm (40,000 μg/m^3)	-
	8-Hour[a]	9 ppm (10,000 μg/m^3)	-
Nitrogen Dioxide (NO_2)	Annual[b]	0.053 ppm (100 μg/m^3)	0.053 ppm (100 μg/m^3)
Ozone (O_3)	1-Hour[c, d]	0.12 ppm (235 μg/m^3)	0.12 ppm (235 μg/m^3)
	8-Hour[e]	0.08 ppm (157 μg/m^3)	0.08 ppm (157 μg/m^3)
Fine Particulate ($PM_{2.5}$)	24-Hour[f, j]	65 μg/m^3	65 μg/m^3
	Annual[g, j]	15 μg/m^3	15 μg/m^3
Lead (Pb)	Quarter[h]	-	1.5 μg/m^3
Respirable Particulate (PM_{10})	24-Hour[a, j]	150 μg/m^3	150 μg/m^3
	Annual[i, j]	50 μg/m^3	50 μg/m^3
Sulfur Dioxide (SO_2)	3-Hour[a]	-	0.5 ppm (1,300 μg/m^3)
	24-Hour[a]	0.14 ppm (365 μg/m^3)	-
	Annual[b]	0.030 ppm (80 μg/m^3)	-

[a] Standard is not to be exceeded more than once per year

[b] Standard is met when the annual arithmetic mean is not exceeded

[c] Standard is met when the expected number of days the standard is exceeded is equal to or less than once per year.

[d] The 1-hour standard does not apply after June 4, 2005.

[e] Standard is met when the three-year average of the annual fourth-highest daily maximum 8-hour average ozone concentrations is less than or equal to 0.08 ppm

[f] Standard is met when the three-year average of the 98th percentile of 24-hour concentrations is less than or equal to 65 μg/m^3

[g] Standard is met when the three year average of the weighted annual mean $PM_{2.5}$ concentrations does not exceed 15.0 μg/m^3

[h] Standard is met when the arithmetic mean average over a calendar quarter is not exceeded

[i] Standard is met when the three-year average of the weighted annual mean does not exceed 50 μg/m^3

[j] EPA revised the air quality standards for particle pollution in 2006. The 2006 standards tighten the 24-hour fine particles ($PM_{2.5}$) standard from the current level of 65 μg/m^3 to 35 μg/m^3, and retain the current annual fine particle ($PM_{2.5}$) standard at 15 μg/m^3. The Agency decided to retain the existing 24-hour PM_{10} standard of 150 μg/m^3. The Agency revoked the annual PM_{10} standard (effective December 17, 2006), because available evidence does not suggest a link between long-term exposure to PM_{10} and health problems.

ug/m^3 = micrograms per cubic meter

ppm = parts per million

NO_2, nitric oxide (NO), and nitrate radical (NO_3) are collectively called oxides of nitrogen (NO_X). These three species are interrelated, often changing from one form to another in chemical reactions. NO_2 is the species commonly measured in ambient air monitors. NO_X is generally emitted in the form of NO, which is oxidized to NO_2. The principal man-made source of NO_X is fuel combustion in motor vehicles and power plants. Reactions of NO_X with other atmospheric chemicals can lead to the formation of O_3 and acidic precipitation.

Ground level O_3 is a secondary pollutant, formed from daytime reactions of NO_X and volatile organic compounds (VOC) rather than being directly emitted by natural and anthropogenic sources. VOCs that have no NAAQS, are released in industrial processes and from evaporation of organic liquids such as gasoline and solvents.

Dominant industrial sources of Pb emissions include waste oil and solid waste incineration, iron and steel production, lead smelting, and battery and lead alkyl manufacturing. The lead content of motor vehicle emissions, which was the major source of lead in the past, has significantly declined with the widespread use of unleaded fuel.

Particulate matter is separated into two different sizes for purposes of the NAAQS: PM_{10} and $PM_{2.5}$. PM_{10} is considered inhalable and $PM_{2.5}$ is considered to be in the respirable range, meaning these particles can reach the alveolar region of the lungs and penetrate deeper than PM_{10}. There are many sources of particulate matter, both natural and man-made, including dust from construction activities, industrial activities, and combustion of fuels.

SO_2 is emitted in natural processes, such as volcanic activity, and by anthropogenic sources such as combustion of fuels containing sulfur, sulfuric acid manufacturing, etc. SO_2 emissions in the atmosphere can lead to the formation of acidic precipitation; i.e., acid rain formation.

The CAA also requires the EPA to assign a designation of each area of the United States regarding compliance with the NAAQS. The EPA categorizes the level of compliance or noncompliance as follows:

- Attainment – area currently meets the NAAQS
- Maintenance – area currently meets the NAAQS, but has previously been out of compliance
- Nonattainment – area currently does not meet the NAAQS.

The HGA is classified as a “moderate” nonattainment area for O_3 and is in attainment for other air contaminants for which a NAAQS has been established.

The TCEQ has the responsibility for developing a plan for attaining the O_3 air quality standard in the HGA. This plan, which was submitted to and approved by the EPA, is called the State Implementation Plan (SIP). The SIP describes how the area will reach attainment of the air quality standard for O_3. The SIP sets emissions budgets for point sources such as power plants; area-wide sources such as dry cleaners and paint shops; off-road mobile sources such as boats and lawn mowers; and on-road sources such as cars, trucks, and motorcycles.

The TCEQ has the lead responsibility for monitoring air and water quality within the state and for reporting that information to the public. The staff examines and interprets the causes, nature, and behavior of air pollution in Texas. The TCEQ also operates central and mobile laboratories based in Austin and a laboratory in Houston that provide analytical services for air, water, and waste samples. Numerous monitors are located in the HGA that are operated by the TCEQ, the City of Houston, and the Houston Regional Monitoring Network in cooperation with the TCEQ.

Most of the monitoring stations measure the concentrations of the criteria pollutants in the air, as well as air temperature, wind velocity, and other meteorological parameters. Some of the monitoring stations also measure the levels of selected chemicals and some measure pollen and mold spores. The O_3 monitors operate continuously 24 hours a day, seven days a week, and are checked by technicians who perform equipment maintenance and conduct quality assurance checks.

3.1.1.2 Conformity of General Federal Actions

As required by the CAA, the EPA has also promulgated rules to ensure that Federal actions conform to the appropriate SIP. Two rules were promulgated: (1) the Transportation Conformity Rule and (2) the General Conformity Rule. The Transportation Conformity Rule applies to Federal Highway Administration and Federal Transit Authority projects within maintenance or nonattainment areas. The General Conformity Rule applies to Federal actions, except Federal Highway Administration and Transit Authority actions, within maintenance or nonattainment areas.

The CAA prohibits Federal agencies from funding, permitting, or licensing any project that does not conform to an applicable SIP. The General Conformity Rule establishes conformity in coordination with and as part of the NEPA process. The rule takes into account air pollution emissions associated with actions that are Federally funded, licensed, permitted, or approved, to ensure emissions do not contribute to air quality degradation, thus preventing the achievement of State and Federal air quality goals. In short, a general conformity determination refers to the process of evaluating plans, programs, and projects to determine and demonstrate they meet the requirements of the CAA and the SIP. The purpose of this General Conformity Rule is to assure Federal agencies consult with state and local air quality districts to assure these regulatory entities know about the expected impacts of the Federal action and would include expected emissions in their SIP emissions budget.

The EPA promulgated the General Conformity Rule as codified in 40 CFR Part 51, Subpart W, and Part 93, "Determining Conformity of Federal Actions to State or Federal Implementation Plans." The TCEQ has promulgated its own corresponding regulations in 30 TAC § 101.30, "Conformity of General Federal Actions to State Implementation Plans." Pursuant to these regulations, a Federal agency must make a general conformity determination for all Federal actions in nonattainment or maintenance areas where the total of direct and indirect emissions of a nonattainment pollutant or its precursors exceeds de minimis levels established by the regulations.

The proposed project would be located in the HGA, classified as a "moderate" nonattainment area. It will require a permit from the USACE to carry out activities related to the channel widening including the dredging and dredged material management activities. The issuance of a Section 404/10 permit from

USACE for project activities is considered a "Federal Action" by the USACE. Therefore, the USACE, in consultation with the TCEQ, must assess whether the emissions that would result from the approval of the project are in conformity with the applicable SIP for the HGA. Only those air contaminant emissions related to the Federal action should be considered in the general conformity determination.

A general conformity determination is required for each year where the total of direct or indirect emissions caused by the Federal action would equal or exceed 100 tons per year (tpy) of NO_X or 100 tpy of VOC. The rule does not apply (i.e., a general conformity determination is not required) to actions where the total of direct or indirect emissions is below these emissions levels. In addition, even if the total of direct and indirect emissions of VOC or NO_X is below 100 tpy, when the total of direct and indirect emissions of any pollutant from the Federal action represents 10% or more of a nonattainment or maintenance area's total emissions of those pollutants, then the action is defined as a regionally significant action and a general conformity determination would be applicable.

3.1.2 Climatology

The primary factors affecting local ambient air quality are the locations of air pollutant sources; the amounts of pollutants emitted; and the meteorological conditions. Atmospheric conditions such as wind speed, wind direction, and air temperature gradients determine the movement and dispersal of air pollutants. Another important factor is the proximity to the Gulf of Mexico, which moderates temperatures and helps create consistent wind gradients.

The local climate is predominantly marine, with periods of modified continental influence during the colder months when cold fronts from the northwest sometimes reach the coast. Because of its coastal location and relatively low latitude, cold fronts that do reach the area seldom have severe temperatures.

Climate normals for Brazoria County were taken from the National Climatic Data Center (NCDC) public database. Climatology data have been recorded since 1946 at three weather stations located in Alvin, Angleton, and Freeport, Texas. Monthly normals of temperature and precipitation as recorded at these three weather stations for the period of 1971 to 2000 are provided in Table 3.1-2.

Mean daily temperatures range from about 55 degrees Fahrenheit (°F) in December and January to above 80°F in the summer months. Minimum temperatures fall as low as 43°F and maximum temperatures rise as high as 92°F.

Monthly rainfall is evenly distributed throughout the year. Average annual precipitation is about 52 inches, 57 inches, and 51 inches for Alvin, Angleton, and Freeport, respectively. Monthly precipitation averages range from about 2.82 inches to 7.80 inches.

Freeze occurrence data was also extracted from the NCDC database for the three monitoring stations in Brazoria County. Table 3.1-3 shows probable dates of the first freeze in fall and the last freeze in spring.

Snowfall is rare. In 95% of the winters, there is no measurable snowfall. In 5%, the snowfall, usually of short duration, is no more than 4 inches. The heaviest 1-day snowfall on record was more than 2 inches.

TABLE 3.1-2

MONTHLY NORMALS OF TEMPERATURE AND PRECIPITATION (1971–2000)
BRAZORIA COUNTY

	Temperature									Precipitation		
	Alvin			Angleton			Freeport			Alvin	Angleton	Freeport
Month	Avg Daily Max °F	Avg Daily Min °F	Avg Daily °F	Avg Daily Max °F	Avg Daily Min °F	Avg Daily °F	Avg Daily Max °F	Avg Daily Min °F	Avg Daily °F	Avg inches	Avg inches	Avg inches
January	62.2	43.1	52.7	62.8	43.7	53.3	62.6	45.4	54.0	4.76	4.76	4.29
February	65.7	46.1	55.9	65.9	46.9	56.4	65.4	47.9	56.7	2.91	3.50	2.84
March	72.0	53.0	62.5	72.1	53.6	62.9	71.5	54.7	63.1	3.11	3.76	2.87
April	77.3	59.6	68.5	77.5	59.6	68.6	76.5	61.4	69.0	3.22	3.74	2.82
May	83.6	67.3	75.5	83.8	67.3	75.6	82.6	69.2	75.9	4.92	5.20	4.02
June	88.8	72.5	80.7	89.1	72.7	80.9	87.8	75.1	81.5	5.35	6.44	4.65
July	91.2	74.2	82.7	91.8	74.2	83.0	90.2	77.2	83.7	4.78	4.24	4.74
August	91.6	73.8	82.7	91.9	73.7	82.8	90.2	76.5	83.4	3.84	4.83	4.18
September	87.7	69.6	78.7	88.1	69.8	79.0	86.7	72.2	79.5	7.12	7.49	7.80
October	80.8	60.4	70.6	81.2	60.3	70.8	80.2	63.5	71.9	3.93	4.25	4.52
November	72.2	52.1	62.2	72.4	52.0	62.2	72.0	54.1	63.1	4.43	4.86	4.42
December	64.7	45.1	54.9	65.1	45.2	55.2	65.0	47.4	56.2	3.36	4.17	3.51
Annual	78.2	59.7	69.0	78.5	59.9	69.2	77.6	62.1	69.8	51.73	57.24	50.6

Source: NCDC, 2006a.

TABLE 3.1-3

FREEZE DATES IN SPRING AND FALL (1971–2000)
BRAZORIA COUNTY

	Freeze Dates (Below 32°F)		
Probability	Alvin	Angleton	Freeport
Last Freeze in Spring			
10	Mar 20	Mar 26	Mar 03
50	Feb 15	Feb 15	Jan 31
90	Jan 10	Jan 04	-
First Freeze in Fall			
10	Jan 01	Dec 29	-
50	Dec 09	Dec 05	Dec 28
90	Nov 19	Nov 13	Nov 28

Source: NCDC, 2006b.

The average humidity in midafternoon is about 60%. Humidity is higher at night, and the average at dawn is about 90%. The sun shines 60% of the time possible in summer and in winter. The prevailing winds are from the south and southeast. Average windspeed, 10 miles per hour, is highest in March (Source: Soil Survey of Brazoria County, Texas, June 1981).

3.1.3 Air Quality Baseline Condition

NO_X and VOCs are considered primary contributors in the formation of O_3; therefore, while neither of these criteria pollutants exceeds the nonattainment criteria individually, they are the targeted pollutants for controlling O_3 formation and, as such, are highly regulated in this area. The HGA is currently in attainment with the NAAQS for all other criteria pollutants; CO, SO_2, PM_{10}, and Pb.

3.1.3.1 Existing Air Emissions Inventory

Based on the most recently available air emissions inventory information provided in the EPA's public database, Table 3.1-4 is a summary of emissions for Brazoria County and the HGA. The emissions information is broken out by area source, point source, highway vehicle, and off-highway vehicle emission categories based on emissions inventory for 2001. Although this emissions inventory is not from more recent years, it is the most current data that has been reviewed and posted by the EPA, and it provides a base from which to compare the proposed project emissions.

TABLE 3.1-4

SUMMARY OF AIR EMISSIONS FOR BRAZORIA COUNTY AND HGA (2001)
BY SOURCE CATEGORY (tpy)

	Source Category	CO	NH_3	NO_X	PM_{10}	$PM_{2.5}$	SO_2	VOC
Brazoria County								
	Area	7,728	966	3,180	37,688	6,678	25	4,373
	Point	11,783	0	32,766	1,285	1,229	10,922	4,907
	Highway Vehicle	45,327	227	6,555	188	141	158	4,112
	Off-Highway Vehicles	17,855	2	11,289	582	535	1,555	2,366
	Total	82,693	1,195	53,790	39,743	8,583	12,660	15,759
HGA								
	Area	89,341	8,652	14,465	289,906	56,660	221	54,928
	Point	82,725	327	164,546	12,719	11,053	118,196	45,764
	Highway Vehicle	858,163	4,806	119,943	3,250	2,339	2,933	78,681
	Off-Highway Vehicles	471,555	44	123,447	6,738	6,186	16,433	35,031
	Total	1,501,784	13,829	422,400	312,613	76,238	137,782	214,403
Brazoria County as a Percent of HGA Emission Source Categories								
	Area	8.7	11.2	22.0	13.0	11.8	11.3	8.0
	Point	14.2	0.0	19.9	10.1	11.1	9.2	10.7
	Highway Vehicle	5.3	4.7	5.5	5.8	6.0	5.4	5.2
	Off-Highway Vehicles	3.8	4.5	9.1	8.6	8.7	9.5	6.8
	Total	5.5	8.6	12.7	12.7	11.3	9.2	7.4

Source: U.S. EPA, 2006a.

Information from the EPA's Air Database identified several point sources in Brazoria County for 1999. The type and number of major industries of these point sources are listed in Table 3.1-5. The major point sources for NO_X, CO, PM_{10}/$PM_{2.5}$, and VOC emissions are from industrial organic chemicals, electrical, petroleum refining, and natural gas industries. Petroleum refining and secondary nonferrous metals industries are the major point sources for SO_2 emissions.

TABLE 3.1-5

TYPE AND NUMBER OF MAJOR INDUSTRIES
IN BRAZORIA COUNTY (1999)

Industry Type (SIC)	Number of Facilities
Industrial Organic Chemicals	13
Electric & Other Services Combined	1
Petroleum Refining	1
Natural Gas Liquids	3
Natural Gas Transmission	5
Crude Petroleum & Natural Gas	11
Plastics Materials And Resins	2
Pipe Lines	5
Gas Transmission And Distribution	2
Petroleum Bulk Stations and Terminals	4
Secondary Nonferrous Metals	1
Miscellaneous	5

Source: U.S. EPA, 2006a.

3.1.3.2 Existing Air Monitoring Data

Table 3.1-6 is a summary of ambient air quality monitored values for criteria pollutants that have been monitored in Brazoria County and the HGA from 1995 through 2005. Monitored values for a specific air contaminant are shown for the duration of time the monitor was actually in operation, and therefore only represent specific periods of time. Currently, there are two operational monitors located in Brazoria County. These monitors are used to measure concentrations of NO_2, O_3, and $PM_{2.5}$ in the ambient air.

As shown in Table 3.1-6, monitored values for NO_2 and $PM_{2.5}$ show that Brazoria County is in attainment with the NAAQS for these air contaminants and monitored values appear to be on the decline. Like the HGA, Brazoria County is in nonattainment with the NAAQS for O_3 with the data showing no clear trend in the concentrations shown.

TABLE 3.1-6

MONITORED VALUES[1] SUMMARY FOR BRAZORIA COUNTY AND HGA[2] (1995–2005)[3]

Year	2nd Max 1-hr Value for CO (ppm)	2nd Max 8-hr Value for CO (ppm)	Annual Mean Value for NO_2 (ppm)	2nd Max 1-hr Value for O_3 (ppm)	4th Max 8-hr Value for O_3 (ppm)	2nd Max 24-hr Value for SO_2 (ppm)	Annual Mean Value for SO_2 (ppm)	98th Percentile – 24-hr Value for $PM_{2.5}$ (μg/m³)	Annual Mean Value for $PM_{2.5}$ (μg/m³)	2nd 24-hr Value for PM_{10} (μg/m³)	Annual Mean Value for PM_{10} (μg/m³)	Quarterly Mean Value for Pb (μg/m³)
Brazoria County												
1995	--	--	--	0.148	0.113	--	--	--	--	--	--	--
1996	--	--	--	0.11	0.079	--	--	--	--	--	--	--
1997	--	--	--	0.137	0.085	--	--	--	--	--	--	--
1998	--	--	--	0.111	0.09	--	--	--	--	--	--	--
1999	--	--	--	0.161	0.112	--	--	--	--	--	--	--
2000	--	--	--	0.136	0.079	--	--	25	10.5	--	--	--
2001	--	--	0.012	0.12	0.086	--	--	25	10.2	--	--	--
2002	--	--	0.009	0.143	0.095	--	--	23	9.5	--	--	--
2003	--	--	0.009	0.121	0.097	--	--	14	8.8	--	--	--
2004	--	--	0.009	0.142	0.103	--	--	--	--	--	--	--
2005	--	--	0.008	0.126	0.092	--	--	--	--	--	--	--
HGA												
1995	11.1	5.2	0.026	0.204	0.14	0.089	0.006	0	0	92	42	0.0225
1996	11.7	7.0	0.023	0.180	0.123	0.067	0.014	0	0	68	40	0.02
1997	9.2	6.7	0.025	0.210	0.134	0.053	0.006	0	0	134	43	0
1998	7.8	5.2	0.023	0.203	0.121	0.039	0.004	0	0	127	54	0
1999	6.3	4.1	0.024	0.203	0.124	0.040	0.007	38	17.1	116	44	0.02
2000	5.7	4.2	0.021	0.194	0.117	0.037	0.006	44	15.4	102	46	0.01
2001	5.7	4.4	0.029	0.170	0.110	0.045	0.005	40	14.8	92	39	0.01
2002	4.4	3.3	0.019	0.171	0.101	0.025	0.004	39	14.5	95	34	0.01
2003	5.4	4.2	0.019	0.193	0.113	0.033	0.006	29	14.7	95	39	0.01
2004	3.6	2.9	0.020	0.152	0.104	0.046	0.007	31	15.0	102	39	0.01
2005	3.0	1.9	0.018	0.153	0.100	0.030	0.007	32	16.6	107	48	0.01
NAAQS	35	9	0.053	0.12	0.08	0.14	0.030	65	15.0	150	50	1.5

-- No monitoring data available.

[1]Selection of monitored values based on criteria established in 40 CFR, Part 50. Parameters and data reported here represent those available in EPA's Aerometric Information Retrieval database: "Air Data-Monitor Values Report."

[2]Data for Chambers, Fort Bend, Liberty, and Waller counties not available in EPA Air Data Report.

[3]2005 available data to date.

Source: EPA, 2006a.

For the HGA, monitored values for O_3 appear to be declining, probably as a result of increased regulations to meet the NAAQS for O_3. Monitored values for CO, NO_2, SO_2, $PM_{10}/PM_{2.5}$, and Pb show the HGA is currently in attainment with the NAAQS for these air contaminants and monitored values generally appear to be declining. However, concentrations of $PM_{10}/PM_{2.5}$ appear to show a slight increase in the last two years compared to the previous year.

3.2 NOISE

3.2.1 Fundamentals and Terminology

Noise is defined as unwanted sound that disrupts or interferes with normal activities, or that diminishes the quality of the environment. Noise is usually caused by human activity and is added to the natural, or ambient, acoustic setting of an area. Exposure to high levels of noise over an extended period can cause health hazards such as hearing loss, however, the most common human response to environmental noise is annoyance. Individuals respond to similar noise events differently based upon various factors that may include the existing background level, noise character, level fluctuation, time of day, the perceived importance of the noise, the appropriateness of the setting, and the sensitivity of the individual.

Sound is sensed by the human ear when a source emits oscillations through an elastic medium, such as air. The vibrations produce alternating bands of dense and sparse particles of air. This movement of the particles creates a fluctuation in the normal atmospheric pressure known as sound waves. Sound is characterized by two magnitudes; frequency and amplitude. The frequency of a sound corresponds to the human sensation of pitch and is measured in Hertz (Hz). The amplitude of a sound corresponds to the human sensation of loudness. Human reaction to loudness, or sound pressure, is measured in terms of sound pressure levels, and expressed in terms of decibels (dB). Decibels are measured on a logarithmic scale in order to compress the wide range between the human threshold of hearing and the threshold of pain. A sound level of 0 dB is approximately the threshold of human hearing and is barely audible under extremely quiet listening conditions. Normal speech has a sound level of approximately 60 dB. Sound levels of approximately 120 dB begin to be felt inside the ear as discomfort and increases to pain at higher levels (EPA, 1976). Table 3.2-1 lists examples of common outdoor and indoor sound and noise levels.

Sounds of the same pressure but different frequencies are not perceived by the human ear as equally loud. The human ear is less sensitive to low frequencies and extremely high frequencies, and most sensitive to the mid-range frequencies that correspond with human speech. Therefore, in order to measure sound in a manner similar to human perception, an adjustment known as “A-weighting” is used. All regulatory agencies require that measurements be taken using the A-weighted sound level (dBA).

Although A-weighted sound measurements indicate the level of environmental noise at any given time, community noise levels vary constantly. Typical noise environments consist of numerous noise sources that vary and fluctuate over time. Because of the varying noise levels within a community, it is necessary to use a descriptor called the equivalent sound level (L_{eq}). L_{eq} provides a way to describe the average sound level, in dB, for any time period under consideration.

TABLE 3.2-1

HEARING: SOUNDS THAT BOMBARD US DAILY

Decibels		
140	Shotgun blast, jet 100 ft away at takeoff	Pain
	Motor test chamber	Human ear pain threshold
130		
	Firecrackers	
120	Severe thunder, pneumatic jackhammer	
	Hockey crowd	
	Amplified rock music	Uncomfortably loud
110		
	Textile loom	
100	Subway train, elevated train, farm tractor	
	Power lawn mower, newspaper press	
	Heavy city traffic, noisy factory	Loud
90		
	Diesel truck 40 mph 50 ft away	
80	Crowded restaurant, garbage disposal	
	Average factory, vacuum cleaner	
	Passenger car 50 mph 50 ft away	Moderately loud
70		
	Quiet typewriter	
60	Singing birds, window air conditioner	
	Quiet automobile	
	Normal conversation, average office	Quiet
50		
	Household refrigerator	
	Quiet office	Very quiet
40		
	Average home	
30	Dripping faucet	
	Whisper 5 ft away	
20		
	Light rainfall, rustle of leaves	
		Average person's threshold of hearing
	Whisper	Just audible
10		
0		Threshold for acute hearing

Source: World Book, Rand McNally Atlas of the Human Body, Encyclopedia Americana, "Industrial Noise and Hearing Conversation" by J.B. Olishifski and E.R. Harford (Researched by N. Jane Hunt and published in the *Chicago Tribune* in an illustrated graphic by Tom Heinz).

Another measurement descriptor of the total noise environment is the Day-Night Sound Level (L_{dn}), which is the A-weighted L_{eq} for a 24-hour period with an additional 10 dB weighting imposed on the L_{eq} occurring during nighttime hours (10 P.M. to 7 A.M.). For example, an environment that has a measured daytime L_{eq} of 60 dBA and a measured nighttime sound level of 50 dBA, would have a weighted nighttime sound level of 60 dBA (50 + 10), and an L_{dn} of 60 dBA. Numerous Federal agencies including the EPA, Department of Defense (DOD), Department of Housing and Urban Development (HUD), and Department of Transportation/Federal Aviation Administration (DOT/FAA) have adopted this descriptor in assessing environmental impacts. Regulatory agencies generally recognize an L_{dn} of 55 dBA as a goal for the outdoor noise environment in residential areas. Studies have found that outdoor noise environments across the United States range from approximately 40 L_{dn} in rural residential areas, to nearly 60 Ldn in older urban residential areas, to as much as 90 Ldn in congested urban settings (EPA, 1974).

3.2.2 Affected Environment

Noise-sensitive receptors are facilities or areas where excessive noise may disrupt normal activity, cause annoyance, or loss of business. Land uses such as residential, religious, educational, recreational, and medical facilities are more sensitive to increased noise levels than are commercial and industrial land uses. Noise-sensitive receptors in the vicinity of the study area are located in the communities of Quintana and Surfside Beach. Single-family residences, RV parks, and recreational areas lie on both sides of the ship channel. The existing noise environment of these communities is affected by a number of sources, most of which are transportation-related (i.e., deep draft shipping, barges, railway, roadway, etc.). Other sources that contribute to the existing noise environment of these communities include activities at nearby heavy industrial sites, such as the DOW chemical plant, and the current maintenance dredging of the ship channel. Measured ambient noise levels at noise-sensitive receptors in these communities ranged between 60.9 and 65.1 Ldn (HFP Acoustical Consultants, Inc., 2002).

3.3 PHYSIOGRAPHY, TOPOGRAPHY, AND BATHYMETRY

The primary physiographic environments of the study area include fluvial deltaic systems, barrier island strandplain systems, and eolian (wind) systems. The Coastal Zone within the study area is underlain by sedimentary deposits that originated in ancient, but similar, physiographic environments. These ancient sediments were deposited by the same natural processes that are currently active in shaping the present coastline such as long shore drift, beach wash, wind deflation and deposition, tidal currents, wind generated waves and currents, delta outbuilding, and river point bar and flood deposition (McGowen et al., 1976).

The project area is characterized by interconnected natural waterways, narrow barrier islands, the GIWW, and ship channels. The surface topography of the project area is mainly flat to gently rolling and slopes to the southeast. The Brazos River drains areas to the west of the project area and discharges into the Gulf of Mexico, forming a delta. A few short, low-gradient streams drain directly into the GIWW, channels, and scattered lakes. Most common among coastal features are beach ridges, open sand beaches, dunes, mudflats, marshes and deltas. A topographic map for the project area is presented on Figure 3.3-1.

The Brazos River is a fine grained meanderbelt system characterized by frequent cutoff and abandoned channel courses, relatively high mud load, and narrow to broad floodplains. Natural ponds, lakes, holding ponds, and artificial reservoirs are present on the floodplains of the Brazos River (McGowen et al., 1976). Dredged material has been placed along most of the turning basins, channels and canals in the project area.

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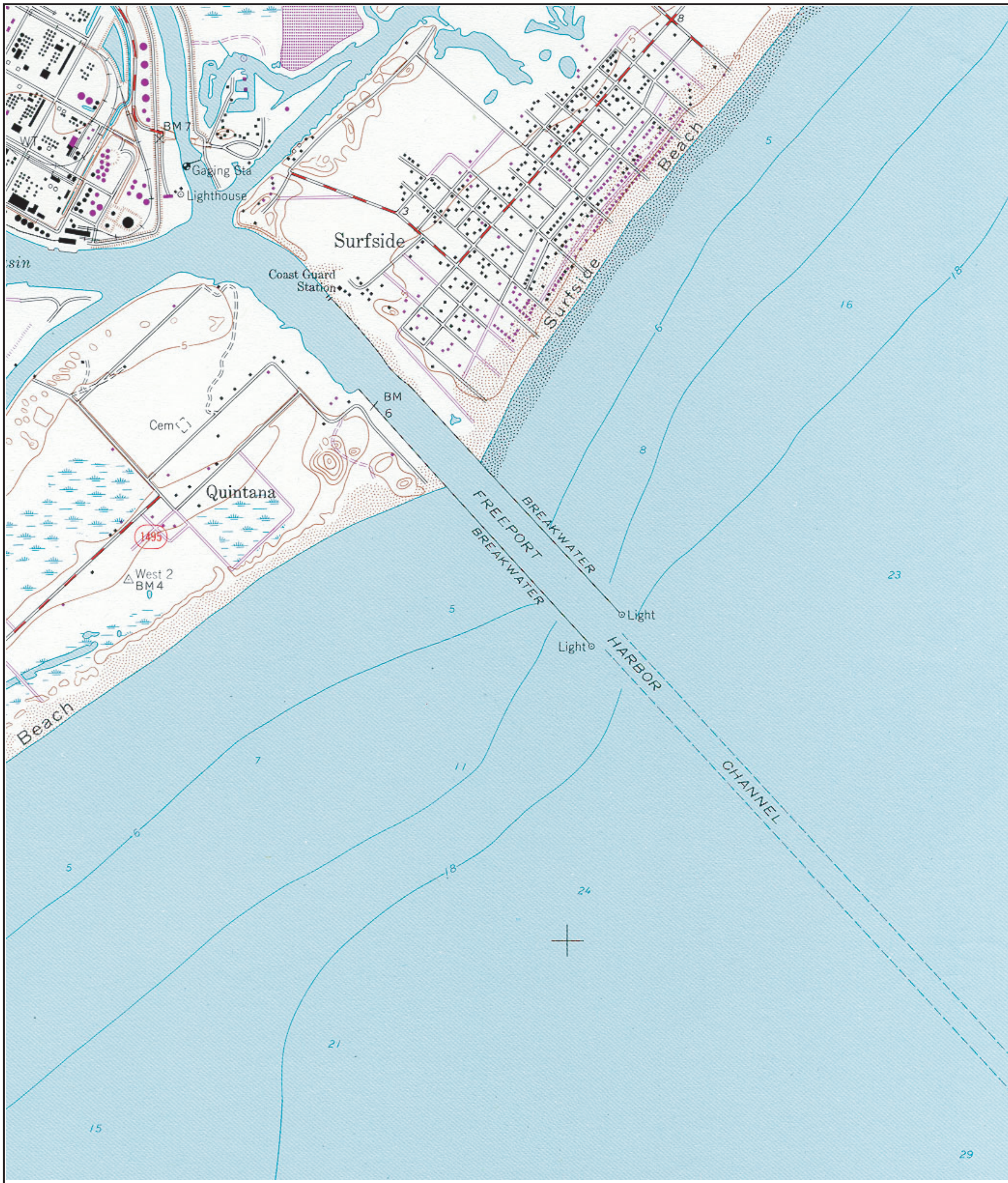

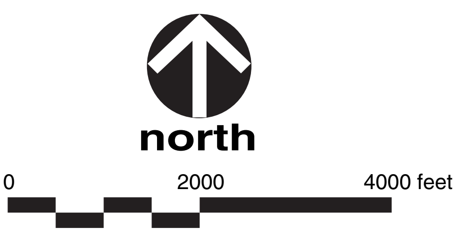

Base Map: USGS 7.5' Quadrangle; Freeport, Texas (1974)

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Figure 3.3-1

TOPOGRAPHIC MAP
OF PORT FREEPORT, TEXAS

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The portion of the Gulf of Mexico pertinent to the project area is confined to the shelf area and is largely devoid of significant physiographic features. The shelf slopes uniformly in the project area at a rate of approximately 5:10,000, except within approximately 3,000 ft of the coastline where the slope is steeper, about 5:1,000. The turning basin and GIWW are relatively low-energy environments protected on the seaward side by beach-ridges and open sand beaches. The Freeport Harbor Channel is a moderate to high energy environment partially protected by two (north/south) man-made rock jetties. These jetties extend into the Gulf approximately 0.5 mile from the shoreline.

The bathymetry of the project area has been partially modified by human activity, mainly by channel dredging and subsequent formation of Dredged Material Placement Area (DMPA). Water depths in the Freeport Harbor Entrance and Jetty Channels are currently maintained by the USACE to a depth of -47 ft MLT. The existing channel is approximately 5.2 miles in length and is approximately 400 ft in width at the bottom and 1,150 ft wide at the water surface. Area tidal channels, passes, and dredged channels are greater than average depth. Water exchange between the Port of Freeport and the Gulf of Mexico is normally limited to natural and artificial tidal passes through both the Freeport Harbor Channel and the GIWW. Fresh water is supplied to the GIWW by the Brazos River and by small streams that drain local areas adjacent to coastal uplands. The bathymetry of the project area is presented in Figure 3.3-2.

3.3.1 Shoreline Changes in Project Area

The shoreline on both the Surfside Beach (northern) and Quintana Beach (southern) areas has moved substantially over the last 150 years. It has been studied extensively and a number of contributing causes have been identified in the literature. Most of the Texas shoreline is now in retreat because of relative sea level rise and a reduced supply of beach sand from changes to the Mississippi and Atchafalaya systems and from reservoirs built on Texas rivers. A major local factor for the Freeport area has been the relocation of the Brazos River in 1929. This was necessary to control what were excessive dredging requirements in the Port of Freeport, but had the side effect of moving the main source of sand away from the immediate project area beaches. Another factor has been reservoir development in the Brazos River watershed that while essential for water supply and flood control, has greatly reduced that sand supply at the relocated Brazos River mouth. The biggest shoreline changes occur with severe storms including:

- Hurricane Carla 1961
- Hurricane Alicia 1983
- Tropical Storm Francis 1998
- Tropical Storm Allison 2001
- Hurricane Rita 2005

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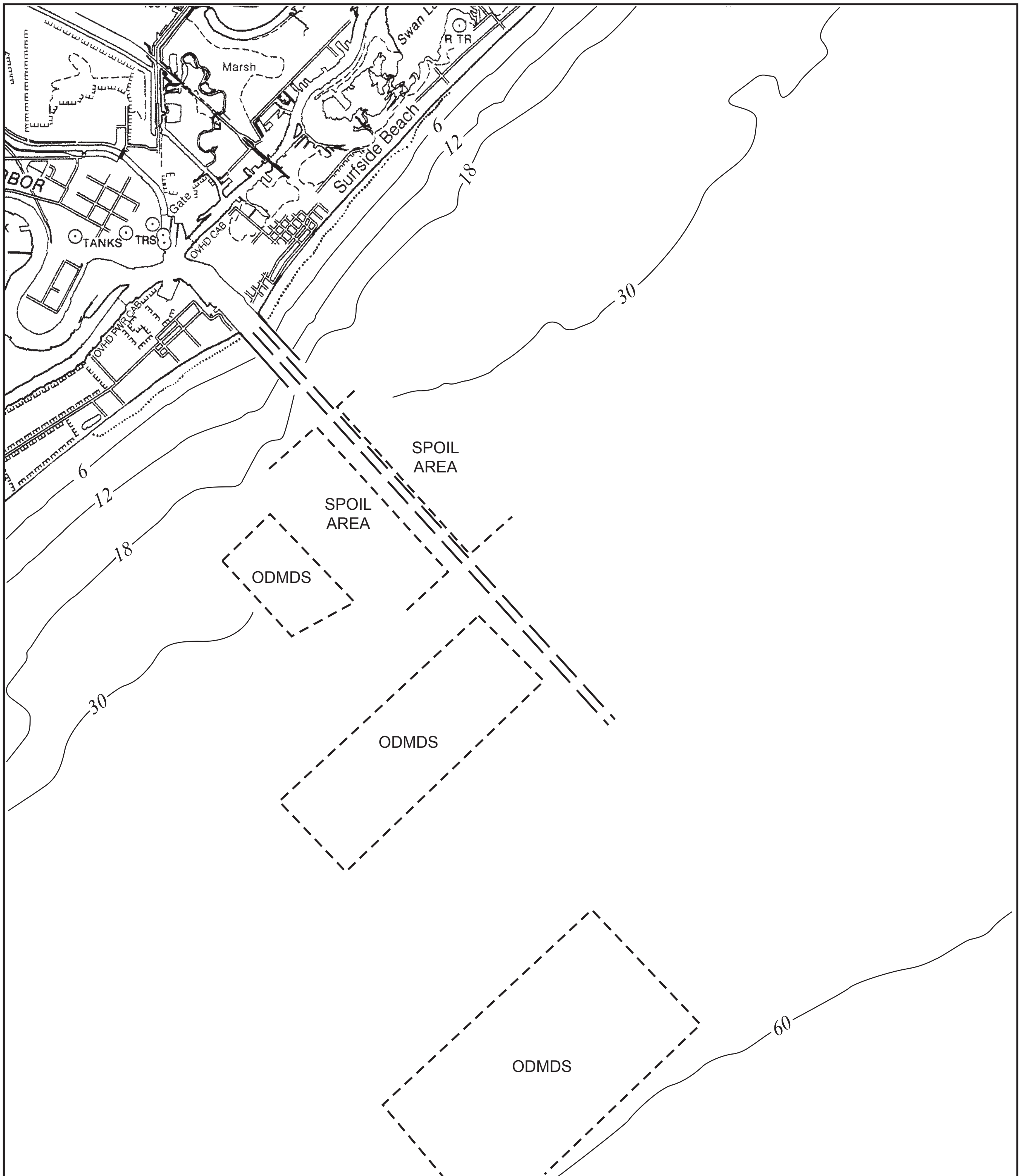

north

0 1 mile

30 Depth in Feet

ODMDS Ocean dredged material disposal site

Base Map: NOAA Navigation Chart 11321 (1990)

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Figure 3.3-2

GENERAL BATHYMETRY
OF PORT FREEPORT, TEXAS

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Other major factors are relative sea level rise that moves the shoreline inland, and a movement of sand from the beach inland by Aeolian drift (wind) aggravated by vehicle traffic on the beaches. Finally, there has been the interception of sand from the longshore system by the navigation channel and jetties. The jetties act as groins to block longshore sediment movement, but some material gets around the jetties and must be periodically dredged from the Freeport Harbor Entrance and Jetty Channels.

Morton (1997) and Gibeaut et al. (2000) have summarized shoreline change information in the project area. Figure 3.3-3 presents data, extracted from Morton (1997) of shoreline positions along transect locations in the Surfside/Quintana area. Figure 3.3-4 is a plot of the shoreline positions for representative years taken from the Morton (1997) transects. All of the shoreline positions are shifted to start with the 1996 position as seen on the shoreline of an aerial photograph from that year. In 1852 the shoreline was well inland from its position today. Between 1852 and 1930 the shoreline at Freeport shows strong accretion. At that point the shoreline was over a mile into what is now the Gulf. However, transects farther west show little change. Following the 1929 relocation of the river, the shoreline at stations 21 and 22, near the new river mouth, advanced substantially while the area around the Freeport jetties retreated rapidly. Between 1958 and 1996 the shoreline has retreated over the entire area.

The shoreline accretion or advance near Freeport between 1852 and 1930 was due to a combination of the deposition of sand supplied by the river and the effect of the jetties (built between 1889 and 1896) (Morton and Pieper, 1975). An intermediate point in the shoreline advance can be seen in Figure 3.3-5, taken from Morton and Pieper (1975). It shows the shoreline at the Brazos River Mouth advancing substantially between 1852 and 1891. Note that the jetty construction began in 1889 and probably had no effect on the shoreline by 1891.

Since 1930 (and the 1929 river relocation), the Surfside stations (13–15) have been relatively stable or slowly retreating and the Quintana stations (16–18) have been retreating more rapidly. This difference appears to reflect the effect of the Freeport jetties acting as groins to block the normal longshore sediment transport towards the southwest. Near the relocated Brazos River mouth (transects 19–22), there was a great advancement of the shoreline between 1930 and 1958. During this period the Brazos River was supplying most of its full sand load. By 1958, reservoir development was substantially reducing the sand supply and since that time the shoreline has been retreating.

A major factor in coastal erosion is the amount of sand supplied to the system. The Brazos River is one of the few that still terminates in the Gulf and historically carried a substantial amount of the sand that advanced the beaches in the area. Mathewson and Minter (1976) analyzed the effect of reservoir development in the Brazos River basin, and found a major reduction in the amount of beach sand supplied since reservoir development started in the 1920s. The first reservoir, Mineral Wells, started impoundment in 1920, and there were 29 completed through 1969. The mechanisms identified and quantified include trapping of sand by reservoirs (95% trapping efficiency for sand is employed) and reduction of peak river flow rates that perform most of the sand transport in the river. The total Brazos River watershed area was noted to be 44,640 square miles, but only 35,400 square miles were contributing in 1975 (Mathewson and

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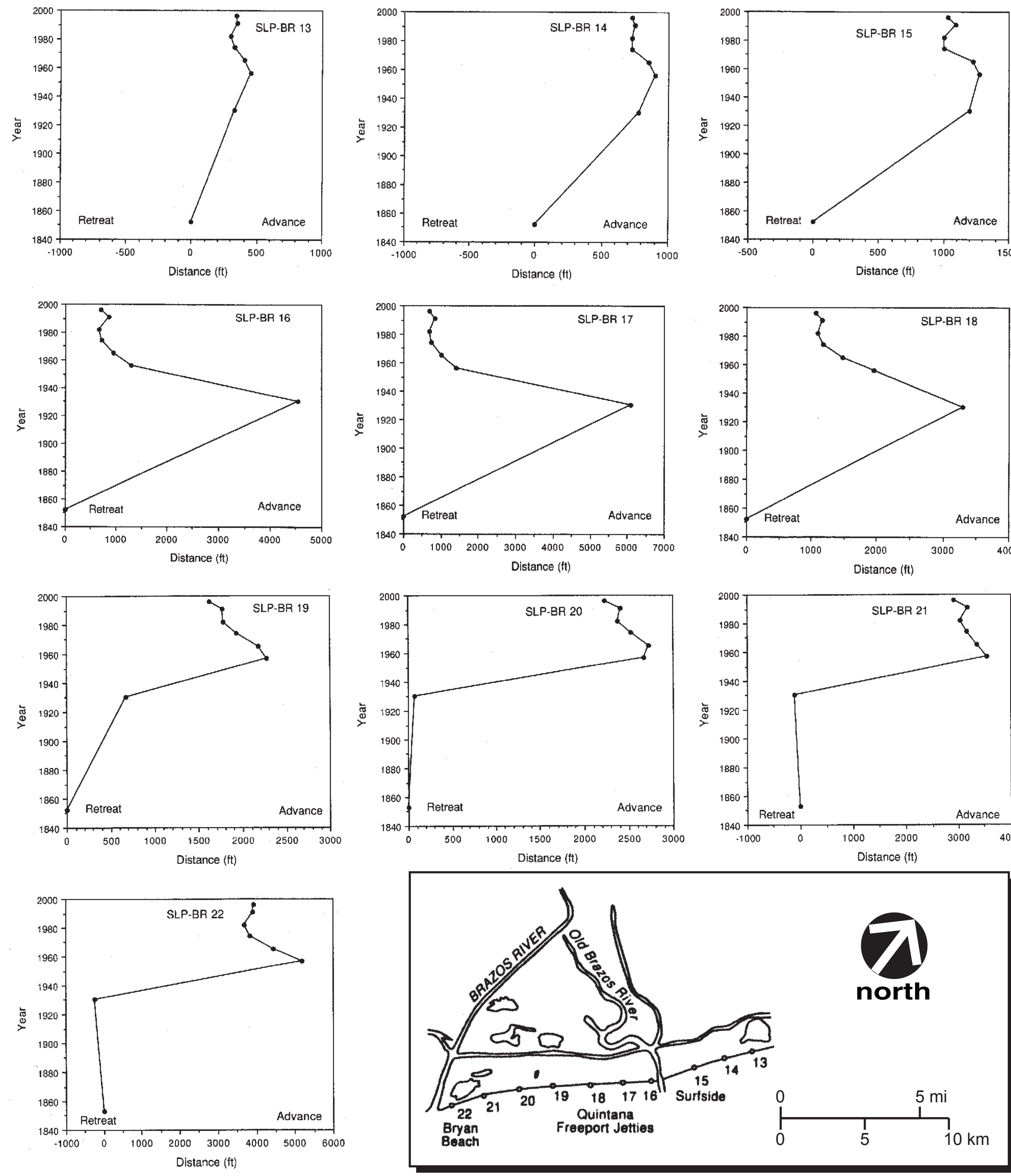

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Figure 3.3-3

SHORELINE CHANGES BY TRANSECT
WITHIN THE PROJECT AREA
1852-1996

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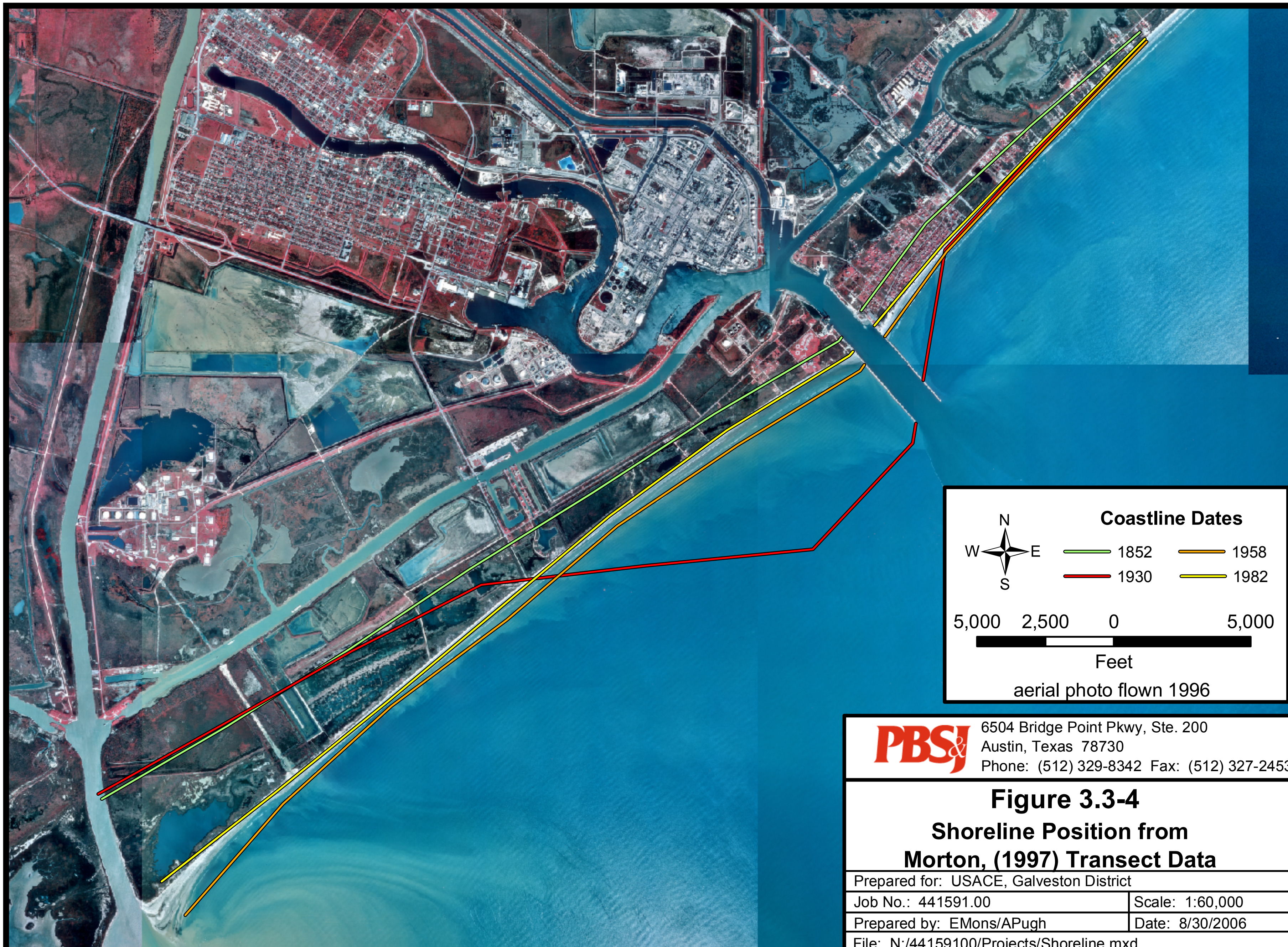

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Austin, Texas 78730
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Figure 3.3-4

Shoreline Position from Morton, (1997) Transect Data

Prepared for: USACE, Galveston District	
Job No.: 441591.00	Scale: 1:60,000
Prepared by: EMons/APugh	Date: 8/30/2006
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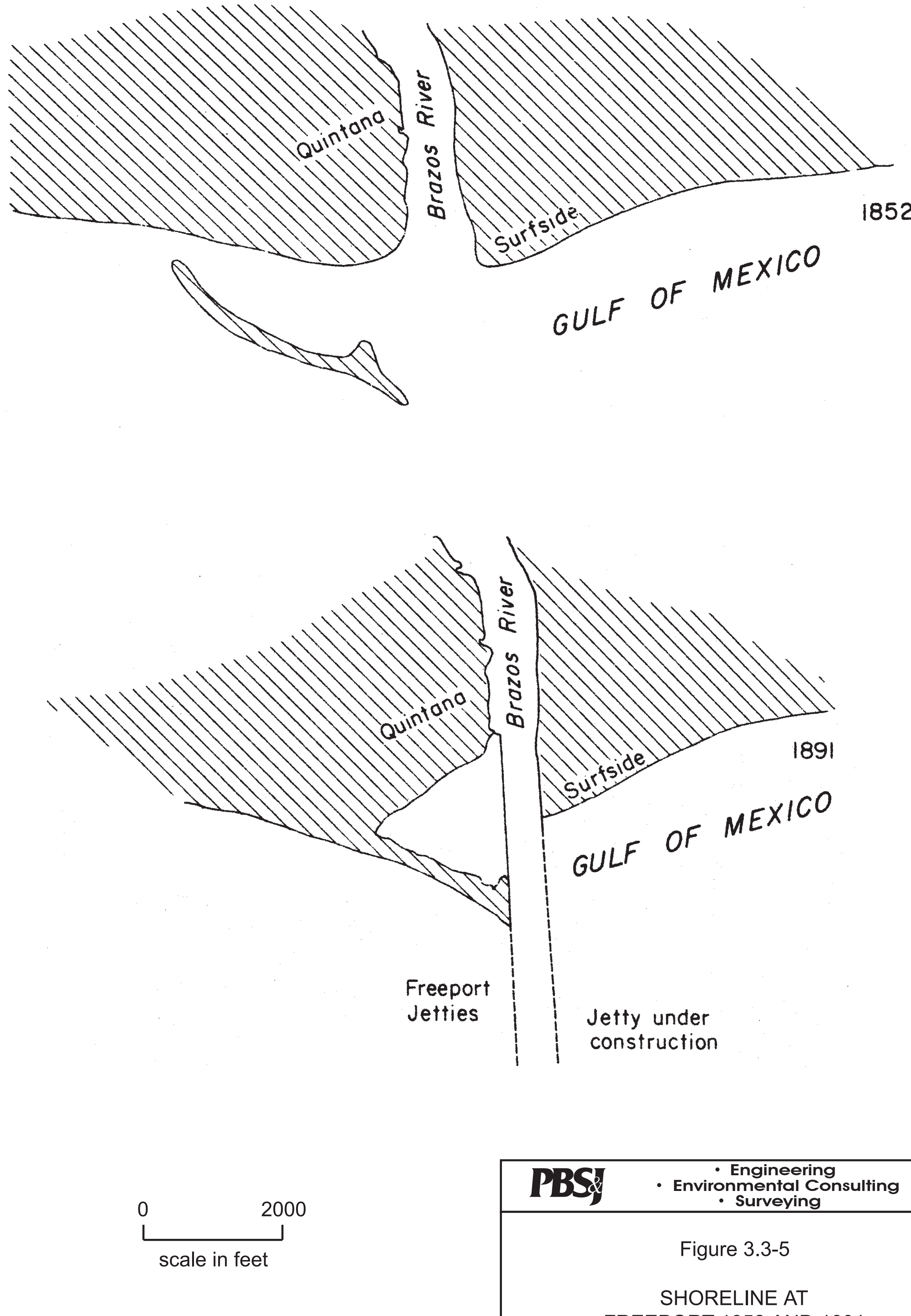

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Figure 3.3-5

SHORELINE AT
FREEPORT 1852 AND 1891
(MORTON & PIEPER, 1975)

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Minter, 1976). The watershed not drained by the major reservoirs in 1975 was noted to be only 10,934 square miles, or about 30% of the contributing watershed. The unregulated watershed is smaller today. The additional reservoirs completed since the Mathewson and Minter study include Lake Limestone, 1978; Lake Granger and Lake Georgetown, 1980; Lake Aquilla, 1983; and Lake Alan Henry, 1994.

In addition to the sand trapping in over 70% of the watershed, reservoirs have also reduced the peak flood discharges that are important in conveying sand in the river to the coast. The reduction in peak flood discharge was found to be larger in the upper basin (52% reduction at Waco) than in the lower basin (30% at Richmond). Mathewson and Minter (1976) estimated that the net effect was that about 76% of the sand that historically reached the coast was not reaching it in 1975. The reduction percentage may be higher today. Their calculations indicate that prior to reservoir development the river transported 101 billion ft^3 of sand or 3.75 million cubic yards per year (mcy/yr) and that the transport rate in the early 1970s was 1.14 mcy/yr. This is a reduction in sand supply to the coast of about 2.6 mcy/yr. This sand would have been supplied during short periods of high river flow, and be distributed both east and west of the river, but predominantly to the west because of the prevailing orientation of onshore winds and longshore drift.

Efforts to offset the erosion with beach nourishment have been carried out under the Texas Coastal Erosion Protection and Response Act (CEPRA). These have involved both trucking in at least 950 cy of sand in one project and bringing sand from a DMPA near Baytown by barge for dune rehabilitation (Newby, 2006). A major limitation of beach nourishment in the area is the limited availability of a suitable sand supply that can be supplied efficiently. Nourishing the beach with sand brought by truck or barge from a substantial distance is relatively expensive. In the early 1990s, approximately 300,000 cy of silty-sand from the 45-ft project deepening of Freeport Harbor Channel was placed on the Surfside Beach (Rodino and Moseley, 2005). Beaches on both sides of the jetties are severely eroded at this time. Erosion on the Quintana Beach side is currently threatening the stability of the Seaway UCPA, and erosion of Surfside Beach is currently threatening beachfront homes.

3.4 GEOLOGY

The study area is situated near the seaward margin of the west Gulf Coastal Plain Physiographic Province. Regionally, the area is characterized by nearly continuous series of marginal marine embayments separated from the Gulf of Mexico by a system of barrier islands and peninsulas (Lankford and Rehkemper, 1969). Coastline features are typically the result of several active, geologic processes including long shore drift, beach wash, wind deflation and deposition, tidal currents and waves, delta outbuilding, and river point bar and flood deposits. The coastal zone is underlain by sedimentary deposits that originated in ancient but similar coastal systems (McGowen et al., 1976).

The coastal plain near the Gulf of Mexico is located within the Gulf Coast geosyncline, a major center of sediment deposition since the middle to late Jurassic Period. More than 30,000 ft of Jurassic to Pleistocene age sedimentary deposits dip and thicken toward the Gulf. During part of the Mesozoic Era (late Triassic to Jurassic), the seas in the area were isolated and water inflow was restricted, resulting in the deposition of evaporate sediments dominated by salt (Wermund et al., 1989). After salt deposition, the region was overlain primarily by prograding sands and muds. Interspersed throughout these layers are salt domes which have migrated upwards through the underlying strata to within a few 1,000 ft of the land surface. In addition, the regional dip is bisected by belts of arcuate growth faults that are typically downthrown to the Gulf, or by faults in the proximity of salt domes.

The project area is characterized as Quaternary (Recent and Holocene) Alluvium containing thick deposits of clay, silt, sand, and gravel (Barnes et al., 1975, 1982), overlying the Pleistocene-age Beaumont Formation. These formations consist mainly of stream channel, point bar, natural levee, and backswamp deposits associated with former and current river channels and bayous. The Alluvium outcrops in a belt that is approximately 70 to 90 miles wide that generally parallels the Texas coastline. The underlying Beaumont Formation is estimated to be less than a 1,000 ft thick and consists mostly of clay, silt, sand, and gravel.

The establishment of GIWW, irrigation and drainage canals, and access channels has resulted in extensive channelization and associated disposal of dredged material in the area (McGowen et al., 1976). The project area is further characterized by recent fill and subaqueous dredged material deposits located on the landward and seaward sides of the barrier beach (Quintana and Surfside), associated with the construction of the Freeport Harbor Channel for the City of Freeport's chemical processing complex. The composition of the material at these locations is dictated by the origin of the material; however, dredging and disposal typically make the material less coherent and more permeable. Typically, fill and dredged material consist of mixed mud, silt, sand, shell and reworked dredged material. Reworked dredged material is commonly sandy and moderately sorted with high to very high permeability and low water-holding capacity.

In 1929, the mouth of the Brazos River was shifted from the area of Surfside, Texas to an area located 6 miles to the west. This diversion of the Brazos River resulted in shoreline erosion in the Surfside area and the construction of a new delta at the mouth of the new Brazos (McGowen et al., 1976). Sediment distributions within the fluviatile-deltaic system consist primarily of sand, silt and mud. Beyond the delta front, is an area of prodelta muds. The sand-mud boundary lies between 2.0 to 2.9 miles offshore from the present Brazos River delta. Muddy sands also occur adjacent to dredged material placement mounds, in the shallow bay margin areas next to the mainland shore and at the edge of wind tidal flats. Muddy sand distribution is not controlled by depth, rather it is related to hurricane washovers, dredging activities, and reworking of relict sediment (McGowen and Morton, 1979).

The shoreface is the gulfward extension of the peninsula and deltaic headland; it extends seaward from the break in slope of the beach to about the 30-ft line (McGowen et al., 1976). The upper shoreface is a zone of high physical energy, especially near the shoreline where waves break (breaker and surf zones). This area extends from mean sea level (msl) to a depth of about 12 ft and consists predominately of sand. The lower shoreface occurs further offshore in the absence of breaking waves, resulting in the deposition of finer grained sediments where biological activity dominates. It consists primarily of extensively burrowed or mottled muddy sand and mud. The middle part of the shoreface (~12 to 30 ft deep) is less muddy than the lower shoreface and is also extensively burrowed. The shelf mud and sand environments of the inner continental shelf extend seaward from about the 30-ft line.

The inner shelf is an area where sands and muds of the lower shoreface and inner shelf are mixed by burrowing organisms. This area undergoes considerable erosion and resedimentation during the hurricane season. Along the Bryan Beach-Surfside area, the sand-mud boundary is from about 0.5 mile to 2.2 miles offshore (McGowen et al., 1976).

Along the coastal zone, subsurface faults are relatively common and a number of these have been activated as a result of subsidence in the area. Most surface faults are related to long-trending coastal fault systems extending upwards from thousands of feet below surface and/or to faults associated with salt domes (Brown et al., 1974). Coastal zone faults form primarily by natural geologic processes, including deposition and differentiation compaction of sediment, upward movement of salt deposits to form diapirs, gulfward creep of coastal landmass, and warping of landmass due to regional tectonics. There are two types of faults that occur in the region, growth and salt dome. Growth faults form by subsurface slumping, creep, and consolidation of sediments during deposition. These faults are confined to Cenozoic-aged sediments and are typically parallel the Gulf Coast, with lengths exceeding 6 miles. Salt dome faults occur in radial and crestal graben type patterns over and around the dome top revealing linear surface traces that are somewhat curved with numerous intersections. These faults are typically localized (<3 miles long) and numerous.

Subsidence occurs as sudden sinking or gradual downward settling of land with little or no horizontal motion, caused by surface faults and intensified and/or accelerated by subsurface mining or the pumping of oil or groundwater. Subsidence is the major manifestation of surface faulting throughout the Texas Gulf Coast, and typically occurs on the downthrown side of the fault. In addition, the extraction of groundwater, oil and gas, and salt brine in the Freeport area (and subsequent active faulting), has caused land subsidence in the order of 1.5 to 2 ft in the area vicinity. However, subsidence has been observed to lessen and diminish altogether as groundwater, oil, and gas pumping has decreased or ceased (Verbeck and Clanton, 1981; Holzer and Gabrysch, 1982).

Several geotechnical studies have been conducted within the project area over the past 40 years. However, the most recent and pertinent study for sediments (virgin and dredged) located in the immediate vicinity of the Freeport Harbor Channel was conducted by Fugro between January 28, 2005 and February 3, 2005 (Fugro, 2005). According to the Fugro report (2005), a total of seven soil borings were drilled inside the channel side of the north and south jetties. The purpose of the geotechnical study was to (1) explore and evaluate subsurface soil conditions at the project site, and (2) to develop geotechnical recommendations to guide others in the design and construction of the proposed Freeport Ship Channel widening project. The sediments reportedly encountered in the borings were indicative of the local geology. Further information pertaining to specific sediment descriptions for the project area can be referenced in the Fugro report (Fugro, 2005).

3.5 ENERGY AND MINERAL RESOURCES

The project area has numerous natural resources, including oil and gas, sulfur, salt, shell, clay, sand, magnesium, and bromine. Among these the most significant is oil and gas (McGowen, 1976). Oil, natural gas and natural gas liquids are major factors in the economy of the area. The major nonagricultural land use of the Freeport area is directly or indirectly related to oil and gas production.

Sulfur generally occurs in the cap rock of certain salt domes but it can also be extracted from sour gas. Sulfur is not commonly used by individual consumers but rather in the manufacture of a variety of products, prominent among them, sulfuric acid. Salt domes are numerous in the area and provide an abundant supply of high-grade sodium chloride. The bulk of Texas salt production comes from the Texas coastal zone. The nearest brine production site is located 3.8 miles east at the Bryan Mound facility. This facility is the former site of a sulfur mine that produced 5 million tons of sulfur between 1918 and 1935.

Associated with the massive salt domes is the underground storage of crude oil. The oil is stored in the cavities created in the salt domes and the liquid hydrocarbons stored in the Texas coast in this manner account for a significant portion of the total liquid hydrocarbon storage in the U.S. The nearest commercial storage facility is located 3.8 miles east at the Bryan Mound facility.

The nearest conventional source of industrial carbonate is approximately 150 miles inland in central Texas. Within the project area shell occurs as discrete reefs and banks mixed with bottom sand and mud in the shallow bays. The oyster *Crassotrea* is the main source of shell. Parts of certain reefs support living oysters while others are composed entirely of dead shells. The physical and chemical properties of shell make it suitable for use as aggregate, road base and the production of lime, cement and chemicals. Historic shell production has depleted oyster reefs in the region, and oysters are no longer commercially mined.

Sand deposits in the area have the potential for industry or specialty uses such as foundry sands, glass sands and chemical silica. Common clays are used in the manufacture of brick and tile. Gypsum, used mainly as a construction raw material, occurs in the caprock deposits of certain salt domes in the area but unlike salt and sulfur is not easily mined and significant production is unlikely. Magnesium compounds and magnesium metal is produced from magnesium chloride which is extracted from sea water in the Freeport-Velasco area. Historically the area has been the largest producer of magnesium metal in the U.S. Similarly, bromine is extracted from sea water in the Freeport area.

3.6 SOILS

The majority of the project area is inundated with salt water from the Gulf of Mexico and is, therefore, incapable of producing and/or sustaining soil associations and series. Mapping by the Soil Conservation Service (SCS, 1979), Soil Survey of Brazoria County, Texas, shows a total of three soil series located within the proposed beach nourishment areas along Quintana Beach and Surfside Beach. Two of the soil series are located along Quintana Beach, the Galveston fine sand, undulating and the Mustang fine sand, saline. The third series is located along Surfside Beach, the Edna-Aris unit. It should be noted that the shoreline boundary presented in 1979 for the Brazoria County soil survey has since eroded further inland and the mapped boundaries for these soil series has probably changed.

The Galveston fine sand, undulating is a nearly level, nonsaline, sandy soil that forms on coastal dunes that parallels the Gulf of Mexico (SCS, 1979). This soil is loose, moderately alkaline, light gray fine sand to about 60 inches thick. The underlying layer is loose, moderately alkaline, gray fine sand about 6 inches thick. Below this, from 66 to 80 inches, is loose, moderately alkaline, light gray fine sand. This soil drains very well, surface runoff is very slow and permeability is very rapid. After heavy rains the water table can rise up to 3 ft in the soil, however in most places the water is saline due to its proximity to the Gulf. This soil is used mainly for recreational areas and as rangeland; however it is not suitable for pastureland or crop production. The potential for urban use is low, the most restrictive features being sandy texture, lateral water seepage, hurricane flooding, and soil wetness. This soil is susceptible to wind erosion when disturbed.

The Mustang fine sand, saline is a nearly level, nonsaline, sandy marshy soil that forms on coastal flats and depressions (SCS, 1979). This soil has a surface layer of neutral, saline, light gray fine sand about 8 inches thick. Below is a layer of neutral, saline, light gray fine sand about 32 inches thick. The underlying layer from 40 to 60 inches is neutral, saline, grayish brown fine sand. This soil is poorly drained, surface runoff is very slow and permeability is rapid above the water table. The water table occurs at depths from 6 to 20 inches below the soil surface, however it is generally saline. Main uses are for rangeland and wildlife habitat. Wetness, salinity, and flooding caused by high tides makes this soil unsuitable for crop production and pastureland. Potential for urban use is low, restrictive features being wetness, soil salinity, and susceptibility to flooding by high tides and hurricanes.

The Edna-Aris unit is about 40% Edna soils, 35% Aris soils, and 25% soils of minor extent (SCS, 1979). Edna soils are a nearly level, nonsaline, sandy loam that forms on coastal flats. This soil has a surface layer of dark gray fine sandy loam about 8 inches thick. Below is very dark gray clay that grades into light brownish gray clay to 60 inches. Aris soils occur at elevations slightly higher than those of the surrounding Edna soils, immediately adjacent to the remnants of old stream meanders. This soil has a surface layer of grayish fine sandy loam about 13 inches thick. From 13 to 20 inches the soil is gray sandy clay loam and from 20 to 50 inches it is grayish clay. Below 60 inches is a reddish yellow sandy clay loam. The Edna-Aris unit is used as pastureland, rangeland, and cropland. This soil unit is poorly drained to somewhat poorly drained and very slowly permeable. The potential of the soils for most urban uses is medium, wetness and the shrink-swell potential being the most limiting features. Of minor extent (<25%) in this map unit are Bernard and Leton soils.

3.7 GROUNDWATER HYDROLOGY

In the Freeport area, the Gulf Coast Aquifer system is the principal source of groundwater for public, agricultural and industrial needs. Within the aquifer system, the Chicot Aquifer is the uppermost aquifer, and all public and private water supply wells in the area are supplied by this aquifer (Texas Water Development Board [TWDB], 2006). The Evangeline aquifer underlies the Chicot Aquifer. The Evangeline aquifer is noted for its abundance of good quality groundwater and is considered one of the most prolific aquifers in the Texas Coastal Plain (Baker, 1979) but is not used in the Freeport area. The Chicot aquifer and Evangeline aquifers are commonly used hydrogeologic-unit designations for subdivisions of the upper, mostly sandy part of the deposits; and the lower permeable zones make up the Jasper aquifer. The geologic and hydrologic units are presented on Figure 3.7-1.

The lithology of the Gulf Coast Aquifer system consists of sand, silt and clay, reflecting three depositional environments: continental (alluvial plain), transitional (delta, lagoon, and beach), and marine (continental shelf). These deposits thicken as they dip toward the Gulf, resulting in a wedge-shaped configuration of the hydrologic units. Numerous retreats and advances of ancient shorelines have resulted in a complex, overlapping mixture of sand, silt and clay. These complex deposits have been divided into seven units (five permeable zones and two confining units) based on permeability differences, water depths and vertical differences in hydraulic head.

As noted above, the Chicot aquifer is the uppermost water-bearing unit in the Gulf Coast Aquifer system. The Chicot-Evangeline boundary runs approximately parallel to the coast, and forms an outcrop about 90 miles inland from Freeport (Baker, 1979). All public, industrial, and private water supply wells in the Freeport area draw from the Chicot aquifer (TWDB, 2006). According to 1999 estimated water use data for Brazoria County, approximately 203 million gallons of groundwater and surface water were withdrawn per day for municipal, manufacturing, irrigation, mining, and livestock uses (TWDB, 2006).

Groundwater recharge into the aquifers occurs primarily by precipitation onto outcropped areas and downward leakage from overlying saturated layers (perched) and/or aquifers. Regional groundwater flow in the aquifers is generally in a southeastward direction from outcrop areas towards areas of natural discharge (Wesselman, 1971). Superimposed upon this natural discharge regime is artificial discharge from groundwater pumping.

A SSA is an aquifer that has been designated by the EPA as the sole or principal source of drinking water for an area. As such, a designated SSA receives special protection. The program for protecting SSA was established by the Safe Drinking Water Act of 1974. The EPA designates an aquifer as a sole source based upon a petition from an individual, company, association, or government entity. The EPA has not designated any sole source aquifers (SSA) within the project area (EPA, 2006b).

Significant changes in groundwater elevation have occurred in the Freeport area over the last 60 years. Water levels dropped nearly 100 ft during the 1940s and 1950s, but began to recover as the rate of groundwater pumping in the area has leveled off (Texas Water Commission, 1963). Depth to groundwater in U.S. Geological Survey (USGS) and TWDB monitored wells remained greater than 70 ft throughout most of the Freeport area through the 1980s (USGS, 2006; TWDB, 2006).

FIGURE 3.7-1
GEOLOGIC AND HYDROLOGIC UNITS WITHIN THE STUDY AREA

<table>
<tr><th>System</th><th>Series</th><th colspan="2">Stratigraphic Unit</th><th colspan="4">Hydrologic Unit</th></tr>
<tr><td rowspan="7">Quaternary</td><td>Holocene</td><td colspan="2">Quaternary Alluvium</td><td rowspan="7">Chicot Aquifer</td><td colspan="2" rowspan="3">Upper Unit</td><td rowspan="12">Gulf Coast Aquifer</td></tr>
<tr><td rowspan="6">Pleistocene</td><td></td><td>Beaumont Clay</td></tr>
<tr><td rowspan="3">Lissie Formation</td><td rowspan="2">Montgomery Formation</td></tr>
<tr><td rowspan="4">Lower Unit</td><td rowspan="3">Alta Loma Sand</td></tr>
<tr><td>Bently Formation</td></tr>
<tr><td colspan="2" rowspan="2">Willis Sand</td></tr>
<tr><td></td></tr>
<tr><td rowspan="5">Tertiary</td><td>Pliocene</td><td colspan="2">Goliad Sand</td><td colspan="3" rowspan="2">Evangeline Aquifer</td></tr>
<tr><td rowspan="4">Miocene</td><td colspan="2" rowspan="4">Fleming Formation</td></tr>
<tr><td colspan="3">Burkeville Aquiclude</td></tr>
<tr><td rowspan="2">Jasper Aquifer</td><td colspan="2">Upper Unit</td></tr>
<tr><td colspan="2">Lower Unit</td></tr>
</table>

Sources: Baker, 1979; Jorgensen, 1975.

Current water levels in the Chicot aquifer in most of southern Brazoria County have remained relatively constant since the late 1970s, with water level elevations of 30 to 50 ft below msl (Coplin and Lanning-Rush, 2002). However, none of the wells monitored for these surveys are located in the Freeport area, which has typically seen the most dramatic fluctuations in water level in southern Brazoria County (Texas Water Commission, 1963).

Records from the TWDB indicate there are a total of three private water supply wells located within 0.25 mile of the existing ship channel boundaries (TWDB, 2006). The nearest, active public supply well (town of Surfside) is located 0.3 mile due northeast. A former (unused) public supply well (town of Quintana) is located less than 0.10 mile due southwest. This well was reportedly drilled in 1895 and is 650 ft deep. All nearby wells are typically screened in the Chicot aquifer and range from 250 to 650 ft in depth.

3.8 HAZARDOUS MATERIAL

The purpose of the Hazardous, Toxic, and Radioactive Waste (HTRW) assessment is to identify indicators of potential hazardous materials or waste issues relating to the study area. The project area for the HTRW assessment is defined by a 1-mile buffer around the centerline of the project channel (see Figure 3.0-1). A review of a regulatory agency database information search was conducted to determine the location and status of sites regulated by the State of Texas and the EPA. A review of oil and gas wells and pipelines located within the project area was also conducted.

The review of the regulatory agency database search indicated a total of 501 records associated with four facilities located within the study area. The vast majority of these records are associated with the same facility (e.g., a facility containing multiple releases, reported spills or emergency response actions). On the basis of the results of the regulatory database searches, the following sites are located within the subject area:

- 1 Corrective Action (CORRACT) site;
- 1 No Further Remedial Action Planned (NFRAP) site;
- 4 petroleum storage tanks (PST);
- 1 leaking underground storage tank (LUST) site;
- 119 reported emergency response (ERNS) actions at two facilities;
- 375 reported spills (SPILLS) at two facilities.

No National Priority List, Comprehensive Environmental Response, Compensation, and Liability Information System, Resource Conservation and Recovery Information System, State Superfund, Voluntary Cleanup Program, or City/County solid waste landfill sites were located within the study area. The Dow facility, which is a CORRACT site and a NFRAP site, is reported to have 374 spill incidents and 117 releases requiring an emergency response.

Examination of the aerial photographic coverage indicated that the project area includes a variety of land uses including residential, heavy industrial, government land, recreational, and maritime. An offshore drilling platform is in wet storage adjacent to Quintana and the jetty channel. The USCG and the Port of Freeport have made numerous unsuccessful attempts to have the owner remove the vessel from its current location. However, chemical analyses of water samples from the platform in January 2006 for trace metals and organic compounds (data supplied by Lisa McMichael, Port of Freeport) detected only 30 µg/L of lead (versus an acute Water Quality Standard of 133 µg/L, see Section 3.9.2), and no organics except the common plasticizer bis(2-ethylhexyl) phthalate at 30 µg/L. An analysis of paint from the platform found 1.3 mg/kg of lead (versus an effects range low [ERL] concentration of 46.7 mg/kg, see Section 3.9.3). Studies indicate that the vessel is a source of slight to moderate environmental impacts to the surrounding environment.

The results of the oil/gas well review indicate that there are no reported well sites located within the project area. A total of five pipelines were identified within the project area. All of these pipelines are listed as active. The pipelines are reported to transport the following material:

- Two natural gas (Enbridge Offshore PLS and Freeport LNG)
- Two crude oil (ExxonMobil Pipeline Co. and ConocoPhillips Co.)
- One product (Dow Chemical Co.)

Based on the findings of the HTRW survey, there is slight potential of encountering contaminated material during construction of the project. In addition, with the laws and regulations governing the handling of hazardous material, there is a decreased risk of future releases of hazardous material causing long term detrimental impacts to the sediments of the project area. However, any activity regarding releases of hazardous material into the waters of the study area and the resulting remediation should be monitored through the regulatory agencies.

3.9 WATER AND SEDIMENT QUALITY

3.9.1 Water Exchange and Inflows

There are two principal types of water exchanges in the Freeport Harbor system: one is bidirectional, involving the tidal exchange with the Gulf of Mexico, and the other is unidirectional and flows from rainfall runoff and wastewater flows that enter the harbor and flow to the Gulf. Of the two, the tidal exchange is by far the largest. When the Brazos River was diverted out of Freeport Harbor in 1929, the remaining local watershed was very small, about 70 square miles. The precise watershed area is difficult to determine because of the flat terrain and the fact that several tributaries enter common bays.

Tidal influence in the Gulf of Mexico is dominated by the 12.4-hour semidiurnal and the 24.8-hour diurnal lunar tides and the 13.6 day cycle in the magnitude of the declination of the moon (Ward, 1977). Tidal exchange moves a volume of water equal to the tidally influenced water surface area times the tidal range. Tidal waters in Freeport Harbor have a total surface area (measured from navigation chart 11321) of approximately 2,550 acres. If the tidal range (elevation difference between low and high water) was 1.5 ft, the volume of water that would need to enter or leave the jetty channel would be 166.5 million cubic ft. If this took place during semidiurnal tides (6.2 hours for a flood or ebb tide), the average tidal flow would be 7,460 cubic feet per second (cfs). The cross-sectional area of the jetty channel is approximately 33,000 square ft so the average tidal current velocity through the channel is only about 0.2 ft/second.

Freshwater inflows from the 70-square-mile watershed are much smaller than the tidal flows. There is no flow measurement in this watershed, but a nearby station can provide an idea of the flows. The USGS gage on Chocolate Bayou near Alvin (08078000) has a drainage area of 87.7 square miles. The average flow from 1959–2001 was 118 cfs. Adjusting for the watershed area gives an average freshwater flow at the Jetty Channel of 94 cfs, much smaller than the average semidiurnal tidal flow of 7,460 cfs.

Frontal passages can cause more rapid changes in water levels and exchanges with the Gulf. As a front approaches from the north, onshore airflow increases, forcing water from the Gulf into the harbor. With frontal passage, the wind direction shifts, forcing water from the harbor into the Gulf. The effect is heightened because the front pushes water away from the coast, causing more water to flow outward.

Storm surges associated with hurricanes can be severe. For example, the observed storm surge during Hurricane Claudette in July 2003 was observed to be around 5.8 ft msl at the tide gauge at Freeport Harbor (Edge et al., 2006) and the surge from Hurricane Carla in late September 1961 was calculated to be almost 11 ft msl.

3.9.2 Water Quality

3.9.2.1 Introduction

The TCEQ has designated the old Brazos River Channel Tidal (Freeport Harbor) as segment 1111. This essentially covers Freeport Harbor. The designated uses for segment 1111 are Contact Recreation (swimming) and High quality aquatic habitat.

TCEQ monitors this station quarterly. Table 3.9-1 summarizes results for the last five years for several key parameters. It can be seen that with little watershed area and freshwater inflow, the average salinity is almost the same as the coastal waters. The minimum salinity is over 18 ppt. Dissolved oxygen (DO) concentrations average 7.2 milligrams per liter (mg/L) and all are well above the criterion for High Quality Aquatic Life use of 4 mg/L. The *Enterococci* concentrations are all well below the criterion of 35 Most Probable Number/deciliter (MPN/dL), indicating that the waters of Freeport Harbor are suitable for contact recreation.

TABLE 3.9-1
SUMMARY OF SURFACE MEASUREMENTS AT STATION 11498, OLD BRAZOS RIVER CHANNEL
MID-WAY BETWEEN MOUTH AND TERMINUS

Parameter	Storetcode	Unit	Start date	End date	Num of data	Average	Minimum	Maximum	Std Dev	Criterion
Dissolved Oxygen	00300	mg/L	3/29/2000	1/3/2006	24	7.2	4.9	10.8	1.4	4.0
Salinity	00480	ppt	3/29/2000	1/3/2006	24	26.7	18.4	33.7	4.0	
Enterococci [1]	31701	MPN/dL	3/13/2001	1/3/2006	20	7.8	<1	20	5.7	35

Source: TCEQ SWQM database, http://www.tceq.state.tx.us/compliance/monitoring/crp/data/samplequery.html
[1] For data below reporting limit, half reporting limit used in calculating average and standard deviation.

3.9.2.2 Water and Elutriate Chemistry

The data collected by the USACE since 1987 were analyzed to determine the water quality of the Project Area (Table 3.9-2). Also included below is a discussion of the elutriate, which provides information on those constituents that are dissolved into the water column during dredging and placement (see Table 3.9-2). Since the elutriate represents the dissolved concentrations that would be expected in the water column, they are compared to the Texas Surface Water Quality Standards (TWQS) provided by the TCEQ (Texas Natural Resources Conservation Commission [TNRCC, now the TCEQ], 2000) for the protection of aquatic life and EPA water quality discrete criteria (WQC). Since the values are from grab samples, not long term composites or averages, and are from a marine environment, the acute marine TWQS and WQC are used for comparison. Sediment data are also included since the elutriate is a measure of the release of constituents from the sediment into the water column and it may be informative to be able to compare elutriate results to sediment results. Also provided in Table 3.9-2, and other tables in this section, are the USACE Channel Stations, which can be compared to Figure 1.1-1 to determine station locations.

Of the metals, silver and thallium were not detected in water or elutriate samples. Selenium was only detected in two of the 11 years for which there are data, 2005 in water samples and 1997 in elutriate samples. Chromium was detected in only three years, 1997 and 1998 in water and 1993 and 1998 in elutriates. Mercury was detected once the water samples (1997) but in no elutriate samples. Nickel was detected in three years for water samples (1988, 1997, and 1999) and five (1988, 1997, 1998, 1999, and 2005) for elutriates. Table 3.9-3 shows the years in which the various constituents in Table 3.9-2 were detected in channel stations, including those that were found more frequently than those noted above. While Placement Area (PA) and reference area samples are included in Table 3.9-2, they are not indicative of water quality in the project area and are not included in Table 3.9-3. Channel stations outside the project area are included, however, since water from the channel inland of the Project Area can influence water quality in the Project Area.

An examination of Table 3.9-2 shows no trends between water and elutriate concentrations in 1987 and only one exceedance of the copper WQC but not the TWQS by a water sample from Brazosport Turning Basin. In 1988, there were no trends except that zinc was found in a couple of water samples where it was not found in the elutriates. There were no exceedances. No constituents were detected in either water or elutriate samples in 1989. Only zinc in one water sample and all elutriate samples, and chromium in a couple of elutriate samples were detected in 1993, none above WQC or TWQS. Barium, for which analyses were conducted only from 1995 through 2000, was detected in both water and elutriate samples in all of those years. There is no WQC or TWQS for barium. Cadmium is the only other constituent found in the 1995 water and elutriate samples, and only in the Jetty and Entrance Channel samples, but the values appear to be aberrant. Before and after 1995, the highest water concentration of cadmium was

4.40 µg/L in 1998 and most were below 0.1 µg/L, while in 1995 the values ranged from 13.6 to 22.0 µg/L. For elutriates, except for 1995, the highest value was 3.60 µg/L, again in 1988, while in 1995, the values ranged from 30.3 µg/L to 56.7 µg/L, and some exceeded the WQC and TWQS. The presence

TABLE 3.9-2

DETECTED PARAMETERS
FREEPORT HARBOR CHANNEL

					Station:	F-87-02			F-87-03			F-87-04			F-87-05		
					Date:	9/24/1987			9/24/1987			9/24/1987			9/24/1987		
					Channel Station:	70+00			113+00			131+00			164+00		
Parameter	Liquid Media Unit	Solid Media Unit	WQC	TWQS	ERL	Water	Elutriate	Sediment	Water	Elutriate	Sediment	Water	Elutriate	Sediment	Water	Elutriate	Sediment
Sand		%															
Silt		%															
Clay		%															
D50		mm															
Arsenic	µg/L	mg/kg	69	149	8.2	<2.0	<2.0		<2.0	<2.0		<2.0	<2.0		<2.0	<2.0	
Barium	µg/L	mg/kg	N/A	N/A	N/A	N/A	N/A		N/A	N/A		N/A	N/A		N/A	N/A	
Cadmium	µg/L	mg/kg	40	45.4	1.20	<2.0	<2.0		<2.0	<2.0		<2.0	<2.0		<2.0	<2.0	
Chromium	µg/L	mg/kg	1,100	1,090	81.0	<10.0	<10.0		<10.0	<10.0		<10.0	<10.0		<10.0	<10.0	
Copper	µg/L	mg/kg	4.8	13.5	34.0	3.3	1.7		**9.2**	2.7		2.5	5.2		3.2	1.2	
Lead	µg/L	mg/kg	210	133	46.7	13	20		19	19		15	22		24	32	
Mercury	µg/L	mg/kg	1.8	2.1	0.15	<0.20	<0.2		<0.20	<0.2		<0.20	<0.2		<0.20	<0.2	
Nickel	µg/L	mg/kg	74	118	20.9	<5.0	<5.0		<5.0	<5.0		<5.0	<5.0		<5.0	<5.0	
Selenium	µg/L	mg/kg	290	564	N/A	<2.0	<2.0		<2.0	<2.0		<2.0	<2.0		<2.0	<2.0	
Silver	µg/L	mg/kg	1.9	2.0	1.00	N/A	N/A		N/A	N/A		N/A	N/A		N/A	N/A	
Thallium	µg/L	mg/kg	N/A	N/A	N/A	N/A	N/A		N/A	N/A		N/A	N/A		N/A	N/A	
Zinc	µg/L	mg/kg	90	92.7	150	55.0	55.0		85.0	7.0		65.0	40.0		52.0	20.0	
TOC	mg/L	%	N/A	N/A	N/A	N/A	N/A		N/A	N/A		N/A	N/A		N/A	N/A	
Total PCB	µg/L	ug/kg	N/A	N/A	N/A	<0.5	<0.5		<0.5	<0.5		<0.5	<0.5		<0.5	<0.5	
Ammonia	mg/L	mg/kg	Var	N/A	N/A	N/A	N/A		N/A	N/A		N/A	N/A		N/A	N/A	

Chromium = CrIII and Total Cr
Var = varies based on pH, salinity, and temperatures
N/A means that no analyses were conducted for a particular parameter in a particular year
WQC = EPA Acute, Marine Water Quality Criterion; TWQS = Texas Acute, Marine Water Quality Standard; ERL = Effects Range Low

TABLE 3.9-2 (Continued)

DETECTED PARAMETERS
FREEPORT HARBOR CHANNEL

					Station:	FH-88-01			FH-88-02			FH-88-03			FH-88-04			FH-88-DA1		
					Date:	3/15/1988			3/15/1988			3/15/1988			3/15/1988			3/15/1988		
					Channel Station:	50+00			0+00			-50+00			-100+00					
Parameter	Liquid Media Unit	Solid Media Unit	WQC	TWQS	ERL	Water	Elutriate	Sediment	Water	Elutriate	Sediment	Water	Elutriate	Sediment	Water	Elutriate	Sediment	Water	Elutriate	Sediment
Sand		%						38.1						39.1			46.8			46.8
Silt		%						48.6						56.9			34.7			34.7
Clay		%						13.3						4.0			18.5			18.5
D50		mm															0.07			0.07
Percent Solids		%																		
Arsenic	µg/L	mg/kg	69	149	8.2	<2.0	<2.0	2.34	<2.0	<2.0	3.03	<2.0	<2.0	2.43	<2.0	<2.0	3.39	<2.0		2.27
Barium	µg/L	mg/kg	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A
Cadmium	µg/L	mg/kg	40	45.4	1.20	3.00	2.40	<0.1	4.00	3.20	<0.1	3.20	3.30	<0.1	3.00	3.60	<0.1	4.40		<0.1
Chromium	µg/L	mg/kg	1,100	1,090	81.0	<10.0	<10.0	8.67	<10.0	<10.0	10.64	<10.0	<10.0	6.80	<10.0	<10.0	13.46	<10.0		8.68
Copper	µg/L	mg/kg	4.8	13.5	34.0	<1.0	<1.0	4.62	<1.0	<1.0	5.32	<1.0	<1.0	2.18	<1.0	<1.0	6.42	4.0		4.20
Lead	µg/L	mg/kg	210	133	46.7	<5.0	<5.0	8.67	<5.0	<5.0	6.72	<5.0	<5.0	4.37	<5.0	<5.0	7.03	<5.0		5.60
Mercury	µg/L	mg/kg	1.8	2.1	0.15	<0.20	<0.2	<0.1	<0.20	<0.2	<0.1	<0.20	<0.2	<0.1	<0.20	<0.2	<0.1	<0.20		<0.1
Nickel	µg/L	mg/kg	74	118	20.9	27.0	25.0	6.94	25.8	21.0	8.12	25.2	24.8	5.58	24.6	28.8	11.01	24.2		7.00
Selenium	µg/L	mg/kg	290	564	N/A	<2.0	<2.0	<1.0	<2.0	<2.0	<1.0	<2.0	<2.0	<1.0	<2.0	<2.0	<1.0	<2.0		<1.0
Silver	µg/L	mg/kg	1.9	2.0	1.00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A
Thallium	µg/L	mg/kg	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A
Zinc	µg/L	mg/kg	90	92.7	150	32.2	<5.0	27.46	26.2	28.8	29.41	89.6	<5.0	21.84	88.6	<5.0	33.03	**98.6**		27.45
TOC	mg/L	%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A
Total PCB	µg/L	ug/kg	N/A	N/A	N/A	<0.5	<0.5	<5.0	<0.5	<0.5	<5.0	<0.5	<0.5	<5.0	<0.5	<0.5	<5.0	<0.5		<5.0
Ammonia	mg/L	mg/kg	Var	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A

Chromium = CrIII and Total Cr
Var = varies based on pH, salinity, and temperatures
N/A means that no analyses were conducted for a particular parameter in a particular year
WQC = EPA Acute, Marine Water Quality Criterion; TWQS = Texas Acute, Marine Water Quality Standard; ERL = Effects Range Low

TABLE 3.9-2 (Continued)

DETECTED PARAMETERS
FREEPORT HARBOR CHANNEL

					Station:	FH-88-REF1			FH-89-01			FH-89-02			FH-89-03			FH-89-04		
					Date:	3/15/1988			4/7/1989			4/7/1989			4/7/1989			4/7/1989		
					Channel Station:				50+00			0+00			-50+00			-110+00		
Parameter	Liquid Media Unit	Solid Media Unit	WQC	TWQS	ERL	Water	Elutriate	Sediment	Water	Elutriate	Sediment	Water	Elutriate	Sediment	Water	Elutriate	Sediment	Water	Elutriate	Sediment
Sand		%						23.6			27.9						33.0			
Silt		%						64.2			47.4						48.0			
Clay		%						12.2			24.7						19.0			
D50		mm									0.05						0.06			
Percent Solids		%																		
Arsenic	µg/L	mg/kg	69	149	8.2	<2.0	<2.0	3.14	<2.0	<2.0	<1.0	<2.0	<2.0	<1.0	<2.0	<2.0	<1.0	<2.0	<2.0	<1.0
Barium	µg/L	mg/kg	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Cadmium	µg/L	mg/kg	40	45.4	1.20	2.60	2.70	<0.1	<2.0	<2.0	<0.1	<2.0	<2.0	<0.1	<2.0	<2.0	<0.1	<2.0	<2.0	<0.1
Chromium	µg/L	mg/kg	1,100	1,090	81.0	<10.0	<10.0	10.11	<10.0	<10.0	5.20	<10.0	<10.0	4.40	<10.0	<10.0	5.20	<10.0	<10.0	4.50
Copper	µg/L	mg/kg	4.8	13.5	34.0	<1.0	<1.0	4.79	<1.0	<1.0	4.50	<1.0	<1.0	2.80	<1.0	<1.0	30.00	<1.0	<1.0	4.90
Lead	µg/L	mg/kg	210	133	46.7	<5.0	<5.0	6.38	<5.0	<5.0	<1.0	<5.0	<5.0	2.20	<5.0	<5.0	2.20	<5.0	<5.0	<1.0
Mercury	µg/L	mg/kg	1.8	2.1	0.15	<0.20	<0.2	<0.1	<0.20	<0.2	<0.1	<0.20	<0.2	<0.1	<0.20	<0.2	<0.1	<0.20	<0.2	<0.1
Nickel	µg/L	mg/kg	74	118	20.9	25.6	27.8	9.04	<5.0	<5.0	5.90	<5.0	<5.0	5.10	<5.0	<5.0	5.70	<5.0	<5.0	6.90
Selenium	µg/L	mg/kg	290	564	N/A	<2.0	<2.0	<1.0	<2.0	<2.0	<0.5	<2.0	<2.0	<0.5	<2.0	<2.0	<0.5	<2.0	<2.0	<0.5
Silver	µg/L	mg/kg	1.9	2.0	1.00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Thallium	µg/L	mg/kg	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Zinc	µg/L	mg/kg	90	92.7	150	39.2	<5.0	30.32	<5.0	<5.0	22.9	<5.0	<5.0	18.5	<5.0	<5.0	20.1	<5.0	<5.0	16.3
TOC	mg/L	%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total PCB	µg/L	ug/kg	N/A	N/A	N/A	<0.5	<0.5	<5.0	<0.5	<0.5	<5.0	<0.5	<0.5	<5.0	<0.5	<0.5	<5.0	<0.5	<0.5	<5.0
Ammonia	mg/L	mg/kg	Var	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Chromium = CrIII and Total Cr
Var = varies based on pH, salinity, and temperatures
N/A means that no analyses were conducted for a particular parameter in a particular year
WQC = EPA Acute, Marine Water Quality Criterion; TWQS = Texas Acute, Marine Water Quality Standard; ERL = Effects Range Low

TABLE 3.9-2 (Continued)

DETECTED PARAMETERS
FREEPORT HARBOR CHANNEL

Station:						FH-89-DA1			FH-89-REF1			FH-93-01			FH-93-02			FH-93-03		
Date:						4/7/1989			4/7/1989			7/20/1993			7/20/1993			7/20/1993		
Channel Station:												50+00			0+00			-50+00		
Parameter	Liquid Media Unit	Solid Media Unit	WQC	TWQS	ERL	Water	Elutriate	Sediment	Water	Elutriate	Sediment	Water	Elutriate	Sediment	Water	Elutriate	Sediment	Water	Elutriate	Sediment
Sand		%									56.2			12.1			49.2			31.4
Silt		%									40.3			38.4			35.6			33.1
Clay		%									3.5			49.5			15.2			35.5
D50		mm									0.08			0.00			0.09			0.02
Percent Solids		%																		
Arsenic	µg/L	mg/kg	69	149	8.2	<2.0		<1.0	<2.0	<2.0	<1.0	<1.0	<1.0	<0.10	<1.0	<1.0	<0.10	<1.0	<1.0	<0.10
Barium	µg/L	mg/kg	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Cadmium	µg/L	mg/kg	40	45.4	1.20	<2.0		<0.1	<2.0	<2.0	<0.1	<0.10	<0.10	0.90	<0.10	<0.10	1.00	<0.10	<0.10	1.20
Chromium	µg/L	mg/kg	1,100	1,090	81.0	<10.0		4.60	<10.0	<10.0	3.90	<1.0	<1.0	11.47	<1.0	3.2	11.30	<1.0	2.7	13.80
Copper	µg/L	mg/kg	4.8	13.5	34.0	<1.0		5.90	<1.0	<1.0	2.60	<1.0	<1.0	5.62	<1.0	<1.0	5.30	<1.0	<1.0	6.27
Lead	µg/L	mg/kg	210	133	46.7	<5.0		1.20	<5.0	<5.0	<1.0	<1.0	<1.0	2.84	<1.0	<1.0	4.20	<1.0	<1.0	4.95
Mercury	µg/L	mg/kg	1.8	2.1	0.15	<0.20		<0.1	<0.20	<0.2	<0.1	<0.20	<0.2	<0.02	<0.20	<0.2	<0.02	<0.20	<0.2	<0.02
Nickel	µg/L	mg/kg	74	118	20.9	<5.0		7.10	<5.0	<5.0	4.90	<1.0	<1.0	7.80	<1.0	<1.0	8.10	<1.0	<1.0	9.70
Selenium	µg/L	mg/kg	290	564	N/A	<2.0		<0.5	<2.0	<2.0	<0.5	<2.0	<2.0	<0.20	<2.0	<2.0	<0.20	<2.0	<2.0	<0.20
Silver	µg/L	mg/kg	1.9	2.0	1.00	N/A		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Thallium	µg/L	mg/kg	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Zinc	µg/L	mg/kg	90	92.7	150	<5.0		14.8	<5.0	<5.0	18.1	2.6	11.1	28.1	<1.0	17.4	30.5	<1.0	15.2	34.7
TOC	mg/L	%	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total PCB	µg/L	ug/kg	N/A	N/A	N/A	<0.5		<5.0	<0.5	<0.5	<5.0	<0.5	<0.5	<50.0	<0.5	<0.5	<50.0	<0.5	<0.5	<50.0
Ammonia	mg/L	mg/kg	Var	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Chromium = CrIII and Total Cr
Var = varies based on pH, salinity, and temperatures
N/A means that no analyses were conducted for a particular parameter in a particular year
WQC = EPA Acute, Marine Water Quality Criterion; TWQS = Texas Acute, Marine Water Quality Standard; ERL = Effects Range Low

TABLE 3.9-2 (Continued)

DETECTED PARAMETERS
FREEPORT HARBOR CHANNEL

					Station:	FH-93-04			FH-93-05			FH-93-DA1			FH-93-REF1			F-95-01		
					Date:	7/20/1993			7/20/1993			7/20/1993			7/20/1993			2/2/1995		
					Channel Station:	-100+00			-150+00									75+00		
Parameter	Liquid Media Unit	Solid Media Unit	WQC	TWQS	ERL	Water	Elutriate	Sediment	Water	Elutriate	Sediment	Water	Elutriate	Sediment	Water	Elutriate	Sediment	Water	Elutriate	Sediment
Sand		%						14.6			16.6			12.7			21.8			
Silt		%						63.7			56.2			63.2			46.8			
Clay		%						21.7			27.2			24.1			31.4			
D50		mm						0.05			0.05			0.02			0.04			
Percent Solids		%																		
Arsenic	µg/L	mg/kg	69	149	8.2	<1.0	<1.0	<0.10	<1.0	<1.0	<0.10	<1.0		<0.10	<1.0	<1.0	<0.10	<1.0	<1.0	
Barium	µg/L	mg/kg	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	37.9	64.8	
Cadmium	µg/L	mg/kg	40	45.4	1.20	<0.10	<0.10	**1.30**	<0.10	<0.10	**1.50**	<0.10		1.10	<0.10	<0.10	1.00	<0.1	<0.1	
Chromium	µg/L	mg/kg	1,100	1,090	81.0	<1.0	<1.0	15.10	<1.0	<1.0	12.60	<1.0		11.70	<1.0	<1.0	12.00	<1.0	<1.0	
Copper	µg/L	mg/kg	4.8	13.5	34.0	<1.0	<1.0	8.60	<1.0	<1.0	5.40	<1.0		4.70	<1.0	<1.0	4.60	<1.0	<1.0	
Lead	µg/L	mg/kg	210	133	46.7	<1.0	<1.0	4.20	<1.0	<1.0	5.50	<1.0		5.10	<1.0	<1.0	4.70	<1.0	<1.0	
Mercury	µg/L	mg/kg	1.8	2.1	0.15	<0.20	<0.2	<0.02	<0.20	<0.2	<0.02	<0.20		<0.02	<0.20	<0.2	<0.02	<0.20	<0.2	
Nickel	µg/L	mg/kg	74	118	20.9	<1.0	<1.0	11.00	<1.0	<1.0	8.80	<1.0		16.30	5.2	<1.0	8.10	<1.0	<1.0	
Selenium	µg/L	mg/kg	290	564	N/A	<2.0	<2.0	<0.20	<2.0	<2.0	<0.20	<2.0		<0.20	<2.0	<2.0	<0.20	<2.0	<2.0	
Silver	µg/L	mg/kg	1.9	2.0	1.00	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	<1.0	<1.0	
Thallium	µg/L	mg/kg	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A	
Zinc	µg/L	mg/kg	90	92.7	150	<1.0	12.9	33.54	<1.0	17.3	30.3	<1.0		30.4	<1.0	52.3	29.7	<1.0	<1.0	
TOC	mg/L	%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Total PCB	µg/L	ug/kg	N/A	N/A	N/A	<0.5	<0.5	<50.0	<0.5	<0.5	<50.0	<0.5		<50.0	<0.5	<0.5	<50.0	<0.5	<0.5	
Ammonia	mg/L	mg/kg	Var	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A	

Chromium = CrIII and Total Cr
Var = varies based on pH, salinity, and temperatures
N/A means that no analyses were conducted for a particular parameter in a particular year
WQC = EPA Acute, Marine Water Quality Criterion; TWQS = Texas Acute, Marine Water Quality Standard; ERL = Effects Range Low

TABLE 3.9-2 (Continued)

DETECTED PARAMETERS
FREEPORT HARBOR CHANNEL

					Station:	F-95-02			F-95-03			F-95-04			FH-95-01			FH-95-02		
					Date:	2/2/1995			2/2/1995			2/2/1995			2/2/1995			2/2/1995		
					Channel Station:	112+00			125+00			175+00			50+00			0+00		
Parameter	Liquid Media Unit	Solid Media Unit	WQC	TWQS	ERL	Water	Elutriate	Sediment	Water	Elutriate	Sediment	Water	Elutriate	Sediment	Water	Elutriate	Sediment	Water	Elutriate	Sediment
Sand		%															6.0			3.0
Silt		%															49.6			50.5
Clay		%															44.4			46.5
D50		mm															0.01			0.05
Percent Solids		%																		
Arsenic	µg/L	mg/kg	69	149	8.2	<1.0	<1.0		<1.0	<1.0		<1.0	<1.0		<1.0	<1.0	<0.10	<1.0	<1.0	<0.10
Barium	µg/L	mg/kg	N/A	N/A	N/A	25.6	49.1		21.1	36.5		20.1	37.2		N/A	N/A	N/A	N/A	N/A	N/A
Cadmium	µg/L	mg/kg	40	45.4	1.20	<0.1	<0.1		<0.1	<0.1		<0.1	<0.1		22.00	**56.70**	**240.30**	13.60	**40.60**	**170.10**
Chromium	µg/L	mg/kg	1,100	1,090	81.0	<1.0	<1.0		<1.0	<1.0		<1.0	<1.0		<1.0	<1.0	<0.10	<1.0	<1.0	<0.10
Copper	µg/L	mg/kg	4.8	13.5	34.0	<1.0	<1.0		<1.0	<1.0		<1.0	<1.0		<1.0	<1.0	30.92	<1.0	<1.0	3.45
Lead	µg/L	mg/kg	210	133	46.7	<1.0	<1.0		<1.0	<1.0		<1.0	<1.0		<1.0	<1.0	13.14	<1.0	<1.0	12.48
Mercury	µg/L	mg/kg	1.8	2.1	0.15	<0.20	<0.2		<0.20	<0.2		<0.20	<0.2		<0.20	<0.2	**9.60**	<0.20	<0.2	**7.63**
Nickel	µg/L	mg/kg	74	118	20.9	<1.0	<1.0		<1.0	<1.0		<1.0	<1.0		<1.0	<1.0	<0.10	<1.0	<1.0	<0.10
Selenium	µg/L	mg/kg	290	564	N/A	<2.0	<2.0		<2.0	<2.0		<2.0	<2.0		<2.0	<2.0	19.02	<2.0	<2.0	17.53
Silver	µg/L	mg/kg	1.9	2.0	1.00	<1.0	<1.0		<1.0	<1.0		<1.0	<1.0		N/A	N/A	N/A	N/A	N/A	N/A
Thallium	µg/L	mg/kg	N/A	N/A	N/A	N/A	N/A		N/A	N/A		N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A
Zinc	µg/L	mg/kg	90	92.7	150	<1.0	<1.0		<1.0	<1.0		<1.0	<1.0		<1.0	<1.0	<0.10	<1.0	<1.0	<0.10
TOC	mg/L	%	N/A	N/A	N/A	N/A	N/A		N/A	N/A		N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A
Total PCB	µg/L	ug/kg	N/A	N/A	N/A	<0.5	<0.5		<0.5	<0.5		<0.5	<0.5		<0.5	<0.5	69.16	<0.5	<0.5	63.45
Ammonia	mg/L	mg/kg	Var	N/A	N/A	N/A	N/A		N/A	N/A		N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A

Chromium = CrIII and Total Cr
Var = varies based on pH, salinity, and temperatures
N/A means that no analyses were conducted for a particular parameter in a particular year
WQC = EPA Acute, Marine Water Quality Criterion; TWQS = Texas Acute, Marine Water Quality Standard; ERL = Effects Range Low

TABLE 3.9-2 (Continued)

DETECTED PARAMETERS
FREEPORT HARBOR CHANNEL

					Station:	FH-95-03			FH-95-04			FH-95-05			FH-95-DA1			FH-95-REF1		
					Date:	2/2/1995			2/2/1995			2/2/1995			2/2/1995			2/2/1995		
					Channel Station:	-50+00			-100+00			-150+00								
Parameter	Liquid Media Unit	Solid Media Unit	WQC	TWQS	ERL	Water	Elutriate	Sediment	Water	Elutriate	Sediment	Water	Elutriate	Sediment	Water	Elutriate	Sediment	Water	Elutriate	Sediment
Sand		%						1.6			0.8			1.6			5.4			6.0
Silt		%						72.5			61.4			66.2			66.4			75.2
Clay		%						25.9			37.8			32.2			28.2			18.8
D50		mm						0.05			0.05			0.05			0.06			0.06
Percent Solids		%																		
Arsenic	µg/L	mg/kg	69	149	8.2	<1.0	<1.0	<0.10	<1.0	<1.0	<0.10	<1.0	<1.0	<0.10	<1.0		<0.10	<1.0	<1.0	<0.10
Barium	µg/L	mg/kg	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A
Cadmium	µg/L	mg/kg	40	45.4	1.20	14.10	30.90	**152.70**	15.00	35.30	**134.60**	14.60	32.00	**244.60**	14.90		**329.10**	15.30	**42.30**	**145.50**
Chromium	µg/L	mg/kg	1,100	1,090	81.0	<1.0	<1.0	<0.10	<1.0	<1.0	<0.10	<1.0	<1.0	<0.10	<1.0		<0.10	<1.0	<1.0	<0.10
Copper	µg/L	mg/kg	4.8	13.5	34.0	<1.0	<1.0	17.71	<1.0	<1.0	26.45	<1.0	<1.0	36.55	<1.0		36.04	<1.0	<1.0	27.86
Lead	µg/L	mg/kg	210	133	46.7	<1.0	<1.0	8.76	<1.0	<1.0	12.40	<1.0	<1.0	16.70	<1.0		15.38	<1.0	<1.0	16.04
Mercury	µg/L	mg/kg	1.8	2.1	0.15	<0.20	<0.2	**8.71**	<0.20	<0.2	**11.03**	<0.20	<0.2	**15.01**	<0.20		**15.40**	<0.20	<0.2	**8.95**
Nickel	µg/L	mg/kg	74	118	20.9	<1.0	<1.0	<0.10	<1.0	<1.0	<0.10	<1.0	<1.0	<0.10	<1.0		<0.10	<1.0	<1.0	<0.10
Selenium	µg/L	mg/kg	290	564	N/A	<2.0	<2.0	13.53	<2.0	<2.0	18.45	<2.0	<2.0	24.27	<2.0		23.07	<2.0	<2.0	20.16
Silver	µg/L	mg/kg	1.9	2.0	1.00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A
Thallium	µg/L	mg/kg	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A
Zinc	µg/L	mg/kg	90	92.7	150	<1.0	<1.0	<0.10	<1.0	<1.0	<0.10	<1.0	<1.0	<0.10	<1.0		<0.10	<1.0	<1.0	<0.10
TOC	mg/L	%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total PCB	µg/L	ug/kg	N/A	N/A	N/A	<0.5	<0.5	**49.96**	<0.5	<0.5	64.65	<0.5	<0.5	93.38	<0.5		88.51	<0.5	<0.5	67.62
Ammonia	mg/L	mg/kg	Var	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A

Chromium = CrIII and Total Cr
Var = varies based on pH, salinity, and temperatures
N/A means that no analyses were conducted for a particular parameter in a particular year
WQC = EPA Acute, Marine Water Quality Criterion; TWQS = Texas Acute, Marine Water Quality Standard; ERL = Effects Range Low

TABLE 3.9-2 (Continued)

DETECTED PARAMETERS
FREEPORT HARBOR CHANNEL

					Station:	F-97-01			FH-97-01			FH-97-03			FH-97-04			FH-97-05		
					Date:	1/25/1997			1/25/1997			1/25/1997			1/25/1997			1/25/1997		
					Channel Station:	75+00			50+00			-50+00			-100+00			-150+00		
Parameter	Liquid Media Unit	Solid Media Unit	WQC	TWQS	ERL	Water	Elutriate	Sediment	Water	Elutriate	Sediment	Water	Elutriate	Sediment	Water	Elutriate	Sediment	Water	Elutriate	Sediment
Sand		%									17.5			27.1			5.8			20.6
Silt		%									34.0			11.6			40.9			21.9
Clay		%									48.5			61.3			53.3			57.5
D50		mm									0.01						0.00			0.00
Percent Solids		%																		
Arsenic	µg/L	mg/kg	69	149	8.2	<1.0	<1.0		<1.0	<1.0	<0.10	<1.0	<1.0	<0.10	<1.0	<1.0	<0.10	<1.0	<1.0	<0.10
Barium	µg/L	mg/kg	N/A	N/A	N/A	26.7	11.3		53.9	45.8	195	41.7	27.8	250	25.1	21.4	124	24.7	22.9	148
Cadmium	µg/L	mg/kg	40	45.4	1.20	<0.1	<0.1		<0.1	<0.1	<0.10	1.69	<0.1	<0.10	<0.1	<0.1	<0.10	<0.1	<0.1	<0.10
Chromium	µg/L	mg/kg	1,100	1,090	81.0	1.32	<1.0		3.42	<1.0	20.7	1.65	<1.0	28.0	<1.0	<1.0	26.3	<1.0	<1.0	34.4
Copper	µg/L	mg/kg	4.8	13.5	34.0	2.35	**5.64**		**10.2**	<1.0	13.6	1.62	**6.01**	16.4	3.99	4.56	18.0	1.25	**6.98**	16.7
Lead	µg/L	mg/kg	210	133	46.7	<1.0	<1.0		<1.0	<1.0	26.8	<1.0	2.4	**47.8**	<1.0	<1.0	19.7	<1.0	1.3	37.2
Mercury	µg/L	mg/kg	1.8	2.1	0.15	<0.20	<0.2		<0.20	<0.2	<0.02	<0.20	<0.2	<0.02	<0.20	<0.2	<0.02	<0.20	<0.2	<0.02
Nickel	µg/L	mg/kg	74	118	20.9	<1.0	<1.0		<1.0	<1.0	15.4	<1.0	<1.0	**23.2**	<1.0	<1.0	**25.5**	<1.0	<1.0	**21.6**
Selenium	µg/L	mg/kg	290	564	N/A	<2.0	<2.0		<2.0	<2.0	<0.20	<2.0	<2.0	<0.20	<2.0	<2.0	<0.20	<2.0	<2.0	<0.20
Silver	µg/L	mg/kg	1.9	2.0	1.00	<1.0	<1.0		<1.0	<1.0	<0.10	<1.0	<1.0	<0.10	<1.0	<1.0	<0.10	<1.0	<1.0	<0.10
Thallium	µg/L	mg/kg	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Zinc	µg/L	mg/kg	90	92.7	150	<1.0	1.9		4.1	8.5	55.8	3.3	4.4	83.1	<1.0	3.3	66.2	<1.0	20.1	59.7
TOC	mg/L	%	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total PCB	µg/L	ug/kg	N/A	N/A	N/A	<0.01	<0.01		<0.01	<0.01	<1.0	<0.01	<0.01	<1.0	<0.01	<0.01	<1.0	<0.01	<0.01	<1.0
Ammonia	mg/L	mg/kg	Var	N/A	N/A	0.14	3.5		0.16	1.9	38.0	<0.03	1.46	23.6	<0.03	0.55	6.30	<0.03	0.63	6.14

Chromium = CrIII and Total Cr
Var = varies based on pH, salinity, and temperatures
N/A means that no analyses were conducted for a particular parameter in a particular year
WQC = EPA Acute, Marine Water Quality Criterion; TWQS = Texas Acute, Marine Water Quality Standard; ERL = Effects Range Low

TABLE 3.9-2 (Continued)

DETECTED PARAMETERS
FREEPORT HARBOR CHANNEL

					Station:	FH-97-PA1A			FH-97-REF1			F-97-01A			FH-97A-01			FH-97A-02		
					Date:	1/25/1997			1/25/1997			9/30/1997			9/30/1997			9/30/1997		
					Channel Station:							75+00			50+00			0+00		
Parameter	Liquid Media Unit	Solid Media Unit	WQC	TWQS	ERL	Water	Elutriate	Sediment	Water	Elutriate	Sediment	Water	Elutriate	Sediment	Water	Elutriate	Sediment	Water	Elutriate	Sediment
Sand		%						18.1			18.7						1.8			1.2
Silt		%						24.7			33.2						40.2			34.5
Clay		%						57.2			48.1						58.0			64.3
D50		mm						0.00			0.01						0.00			0.00
Percent Solids		%																		
Arsenic	µg/L	mg/kg	69	149	8.2	<1.0		<0.10	<1.0	<1.0	<0.10	<1.0	10.3		<1.0	2.3	3.05	<1.0	<1.0	2.27
Barium	µg/L	mg/kg	N/A	N/A	N/A	25.7		110.0	25.1	17.4	217.0	20.4	60.0		21.7	106.0	144.0	19.2	58.0	98.6
Cadmium	µg/L	mg/kg	40	45.4	1.20	<0.1		<0.10	<0.1	<0.1	<0.10	<0.1	<0.1		<0.1	<0.1	<0.10	<0.1	<0.1	<0.10
Chromium	µg/L	mg/kg	1,100	1,090	81.0	<1.0		33.9	<1.0	<1.0	22.1	<1.0	<1.0		<1.0	<1.0	16.7	<1.0	<1.0	20.7
Copper	µg/L	mg/kg	4.8	13.5	34.0	<1.00		19.3	1.80	4.36	13.6	1.20	<1.00		<1.00	<1.00	11.1	<1.00	<1.00	11.0
Lead	µg/L	mg/kg	210	133	46.7	<1.0		45.0	<1.0	<1.0	25.3	<1.0	<1.0		<1.0	1.0	2.55	<1.0	3.4	3.04
Mercury	µg/L	mg/kg	1.8	2.1	0.15	<0.20		<0.02	<0.20	<0.2	<0.02	<0.20	<0.20		<0.20	<0.20	<0.02	<0.20	<0.20	<0.02
Nickel	µg/L	mg/kg	74	118	20.9	<1.0		**23.1**	<1.0	<1.0	18.9	<1.0	1.0		1.0	1.0	14.7	2.8	1.0	16.5
Selenium	µg/L	mg/kg	290	564	N/A	<2.0		<0.20	<2.0	<2.0	<0.20	<1.0	<1.0		<1.0	1.8	<0.20	<1.0	2.7	<0.20
Silver	µg/L	mg/kg	1.9	2.0	1.00	<1.0		<0.10	<1.0	<1.0	<0.10	<1.0	<1.0		<1.0	<1.0	<0.10	<1.0	<1.0	<0.10
Thallium	µg/L	mg/kg	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A
Zinc	µg/L	mg/kg	90	92.7	150	<1.0		62.4	<1.0	4.3	52.3	2.5	8.9		<1.0	10.6	49.3	1.8	22.5	64.5
TOC	mg/L	%	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A
Total PCB	µg/L	ug/kg	N/A	N/A	N/A	<0.01		<1.0	<0.01	<0.01	<1.0	<0.01	<0.01		<0.01	<0.01	<1.00	<0.01	<0.01	<1.00
Ammonia	mg/L	mg/kg	Var	N/A	N/A	<0.03		6.58	<0.03	0.64	6.74	<0.03	<0.03		<0.03	<0.03	41.5	<0.03	<0.03	31.1

Chromium = CrIII and Total Cr
Var = varies based on pH, salinity, and temperatures
N/A means that no analyses were conducted for a particular parameter in a particular year
WQC = EPA Acute, Marine Water Quality Criterion; TWQS = Texas Acute, Marine Water Quality Standard; ERL = Effects Range Low

TABLE 3.9-2 (Continued)

DETECTED PARAMETERS
FREEPORT HARBOR CHANNEL

					Station:	FH-97A-03			FH-97A-04			FH-97A-PA1A			FH-97A-REF1			F-98-01		
					Date:	9/30/1997			9/30/1997			9/30/1997			9/30/1997			3/3/1998		
					Channel Station:	-50+00			-100+00									75+00		
Parameter	Liquid Media Unit	Solid Media Unit	WQC	TWQS	ERL	Water	Elutriate	Sediment	Water	Elutriate	Sediment	Water	Elutriate	Sediment	Water	Elutriate	Sediment	Water	Elutriate	Sediment
Sand		%						11.1			1.4			6.7			8.8			
Silt		%						28.7			25.8			48.8			38.5			
Clay		%						60.2			72.8			44.5			52.7			
D50		mm						0.00			0.00			0.01			0.00			
Arsenic	µg/L	mg/kg	69	149	8.2	<1.0	<1.0	2.82	<1.0	3.6	2.93	<1.0	8.0	2.96	<1.0	8.0	3.66	<1.00	<1.00	
Barium	µg/L	mg/kg	N/A	N/A	N/A	26.6	46.0	156.0	23.7	61.0	95.1	24.7	56.0	231.0	17.6	28.0	208.0	50.9	59.8	
Cadmium	µg/L	mg/kg	40	45.4	1.20	<0.1	<0.1	<0.10	<0.1	<0.1	<0.10	<0.1	<0.1	<0.10	<0.1	<0.1	<0.10	0.26	1.00	
Chromium	µg/L	mg/kg	1,100	1,090	81.0	<1.0	<1.0	15.9	1.9	<1.0	21.1	<1.0	<1.0	16.1	<1.0	<1.0	22.9	5.9	2.9	
Copper	µg/L	mg/kg	4.8	13.5	34.0	<1.00	<1.00	9.9	<1.00	<1.00	14.8	<1.00	<1.00	9.77	<1.00	<1.00	11.3	3.25	1.10	
Lead	µg/L	mg/kg	210	133	46.7	<1.0	<1.0	3.36	<1.0	1.5	2.98	1.07	<1.0	3.26	<1.0	<1.0	3.23	<1.00	<1.00	
Mercury	µg/L	mg/kg	1.8	2.1	0.15	<0.20	<0.20	0.02	0.3	<0.20	<0.02		<0.20	0.02		<0.20	0.02	<0.20	<0.20	
Nickel	µg/L	mg/kg	74	118	20.9	<1.0	1.0	15.1	<1.0	1.0	19.2	<1.0	1.0	15.6	<1.0	1.0	18.9	<1.00	<1.00	
Selenium	µg/L	mg/kg	290	564	N/A	<1.0	3.5	<0.20	<1.0	3.9	<0.20	<1.0	<1.0	<0.20	<1.0	<1.0	<0.20	<1.00	<1.00	
Silver	µg/L	mg/kg	1.9	2.0	1.00	<1.0	<1.0	<0.10	<1.0	<1.0	<0.10	<1.0	<1.0	<0.10	<1.0	<1.0	<0.10	<1.00	<1.00	
Thallium	µg/L	mg/kg	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Zinc	µg/L	mg/kg	90	92.7	150	1.2	27.0	55.8	4.9	21.2	52.9	<1.0	10.3	55.4	6.1	14.4	70.0	8.50	<1.00	
TOC	mg/L	%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2.90	6.00	
Total PCB	µg/L	ug/kg	N/A	N/A	N/A	<0.01	<0.01	<1.00	<0.01	<0.01	<1.00	<0.01	<0.01	<1.00	<0.01	<0.01	<1.00	<0.01	<0.01	
Ammonia	mg/L	mg/kg	Var	N/A	N/A	<0.03	<0.03	29.4	<0.03	<0.03	3.30	<0.03	<0.03	4.10	<0.03	<0.03	3.84	N/A	N/A	

Chromium = CrIII and Total Cr
Var = varies based on pH, salinity, and temperatures
N/A means that no analyses were conducted for a particular parameter in a particular year
WQC = EPA Acute, Marine Water Quality Criterion; TWQS = Texas Acute, Marine Water Quality Standard; ERL = Effects Range Low

TABLE 3.9-2 (Continued)

DETECTED PARAMETERS
FREEPORT HARBOR CHANNEL

					Station:	F-98-02			F-98-03			F-98-04			FH-98-01			FH-98-02		
					Date:	3/3/1998			3/3/1998			3/3/1998			9/30/1997			9/30/1997		
					Channel Station:	112+00			125+00			175+00			50+00			0+00		
Parameter	Liquid Media Unit	Solid Media Unit	WQC	TWQS	ERL	Water	Elutriate	Sediment	Water	Elutriate	Sediment	Water	Elutriate	Sediment	Water	Elutriate	Sediment	Water	Elutriate	Sediment
Sand		%															3.6			4.8
Silt		%															28.2			37.3
Clay		%															68.2			57.9
H		mm															0.00			0.00
Arsenic	µg/L	mg/kg	69	149	8.2	<1.00	2.90		2.50	2.50		2.89	1.70		<1.00	<1.00	5.81	<1.00	<1.00	4.87
Barium	µg/L	mg/kg	N/A	N/A	N/A	38.6	152.0		45.6	97.7		71.8	101.0		31.1	66.7	116	34.9	62.2	103
Cadmium	µg/L	mg/kg	40	45.4	1.20	0.18	0.40		0.17	0.40		0.24	0.40		<0.10	<0.10	0.10	<0.10	<0.10	<0.10
Chromium	µg/L	mg/kg	1,100	1,090	81.0	3.8	8.5		2.1	5.2		2.5	7.2		<1.0	<1.0	17.4	<1.0	<1.0	17.9
Copper	µg/L	mg/kg	4.8	13.5	34.0	3.50	<1.00		1.40	<1.00		1.00	<1.00		<1.00	3.11	6.53	<1.00	<1.00	12.90
Lead	µg/L	mg/kg	210	133	46.7	<1.00	<1.00		<1.00	<1.00		<1.00	<1.00		<1.0	<1.0	4.24	<1.0	<1.0	3.92
Mercury	µg/L	mg/kg	1.8	2.1	0.15	<0.20	<0.20		<0.20	<0.20		<0.20	<0.20		<0.20	<0.20	0.07	<0.20	<0.20	0.06
Nickel	µg/L	mg/kg	74	118	20.9	<1.00	<1.00		<1.00	<1.00		<1.00	<1.00		<1.00	1.47	13.1	<1.00	1.94	14.0
Selenium	µg/L	mg/kg	290	564	N/A	<1.00	<1.00		<1.00	<1.00		<1.00	<1.00		<1.00	<1.0	<0.20	<1.00	<1.0	<0.20
Silver	µg/L	mg/kg	1.9	2.0	1.00	<1.00	<1.00		<1.00	<1.00		<1.00	<1.00		<1.0	<1.0	<0.10	<1.0	<1.0	<0.10
Thallium	µg/L	mg/kg	N/A	N/A	N/A	N/A	N/A		N/A	N/A		N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A
Zinc	µg/L	mg/kg	90	92.7	150	11.30	<1.00		2.30	<1.00		7.60	<1.00		11.6	4.6	47.4	10.1	1.5	46.5
TOC	mg/L	%	N/A	N/A	N/A	3.90	5.80		4.00	5.60		4.10	7.00		<1.00	<1.00	14300	<1.00	<1.00	13600
Total PCB	µg/L	ug/kg	N/A	N/A	N/A	<0.01	<0.01		<0.01	<0.01		<0.01	<0.01		<0.01	<0.01	<1.00	<0.01	<0.01	<1.00
Ammonia	mg/L	mg/kg	Var	N/A	N/A	N/A	N/A		N/A	N/A		N/A	N/A		<0.03	0.22	38.7	<0.03	5.87	50.4

Chromium = CrIII and Total Cr
Var = varies based on pH, salinity, and temperatures
N/A means that no analyses were conducted for a particular parameter in a particular year
WQC = EPA Acute, Marine Water Quality Criterion; TWQS = Texas Acute, Marine Water Quality Standard; ERL = Effects Range Low

TABLE 3.9-2 (Continued)

DETECTED PARAMETERS
FREEPORT HARBOR CHANNEL

					Station:	FH-98-03			FH-98-04			FH-98-05			FH-98-PA1A			FH-98-REF1		
					Date:	9/30/1997			9/30/1997			9/30/1997			9/30/1997			9/30/1997		
					Channel Station:	-50+00			-100+00			-150+00								
Parameter	Liquid Media Unit	Solid Media Unit	WQC	TWQS	ERL	Water	Elutriate	Sediment	Water	Elutriate	Sediment	Water	Elutriate	Sediment	Water	Elutriate	Sediment	Water	Elutriate	Sediment
Sand		%						54.9			4.3			3.3			1.6			21.9
Silt		%						7.4			43.6			19.0			44.3			41.0
Clay		%						37.7			52.1			77.7			54.1			37.1
D50		mm						0.06			0.00			0.00			0.00			0.02
Percent Solids		%																		
Arsenic	µg/L	mg/kg	69	149	8.2	<1.00	<1.00	4.28	<1.00	<1.00	6.34	<1.00	<1.00	6.13	<1.00		5.77	<1.00	<1.00	3.94
Barium	µg/L	mg/kg	N/A	N/A	N/A	28.8	57.7	100	23.6	45.1	210	22.1	52.7	187	23.7		151	22.2	57.9	122
Cadmium	µg/L	mg/kg	40	45.4	1.20	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.35	<0.10	<0.10	0.17		0.14	<0.10	<0.10	<0.10
Chromium	µg/L	mg/kg	1,100	1,090	81.0	<1.0	<1.0	16.4	<1.0	<1.0	22.7	<1.0	<1.0	17.8	<1.0		17.9	<1.0	<1.0	13.5
Copper	µg/L	mg/kg	4.8	13.5	34.0	<1.00	<1.00	11.85	<1.00	<1.00	15.20	<1.00	<1.00	13.20	<1.00		12.10	<1.00	<1.00	9.83
Lead	µg/L	mg/kg	210	133	46.7	<1.0	<1.0	3.51	<1.0	<1.0	5.29	<1.0	<1.0	4.33	<1.0		4.58	<1.0	<1.0	3.41
Mercury	µg/L	mg/kg	1.8	2.1	0.15	<0.20	<0.20	0.05	<0.20	<0.20	**0.21**	<0.20	<0.20	0.07	<0.20		0.02	<0.20	<0.20	0.05
Nickel	µg/L	mg/kg	74	118	20.9	<1.00	1.05	14.4	<1.00	1.35	17.1	<1.00	2.78	14.4	<1.00		15.4	<1.00	<1.00	12.1
Selenium	µg/L	mg/kg	290	564	N/A	<1.00	<1.00	<0.20	<1.00	<1.00	<0.20	<1.00	<1.00	<0.20	<1.00		<0.20	<1.00	<1.00	<0.20
Silver	µg/L	mg/kg	1.9	2.0	1.00	<1.0	<1.0	<0.10	<1.0	<1.0	0.19	<1.0	<1.0	<0.10	<1.0		0.23	<1.0	<1.0	<0.10
Thallium	µg/L	mg/kg	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A
Zinc	µg/L	mg/kg	90	92.7	150	20.3	1.7	43.0	7.0	<1.0	61.9	6.2	2.1	52.1	20.5		51.8	10.6	1.1	44.2
TOC	mg/L	%	N/A	N/A	N/A	<1.00	<1.00	6250	<1.00	<1.00	11300	<1.00	<1.00	11800	<1.00		7350	<1.00	<1.00	6880
Total PCB	µg/L	ug/kg	N/A	N/A	N/A	<0.01	<0.01	<1.00	<0.01	<0.01	<1.00	<0.01	<0.01	<1.00	<0.01		<1.00	<0.01	<0.01	<1.00
Ammonia	mg/L	mg/kg	Var	N/A	N/A	<0.03	2.93	11.9	<0.03	1.67	26.6	<0.03	2.94	25.2	<0.03		11.8	<0.03	5.70	5.70

Chromium = CrIII and Total Cr
Var = varies based on pH, salinity, and temperatures
N/A means that no analyses were conducted for a particular parameter in a particular year
WQC = EPA Acute, Marine Water Quality Criterion; TWQS = Texas Acute, Marine Water Quality Standard; ERL = Effects Range Low

TABLE 3.9-2 (Continued)

DETECTED PARAMETERS
FREEPORT HARBOR CHANNEL

Station:						FH-99-01			FH-99-01DUP			F-99-02			F-99-03			FH-H-00-01		
Date:						7/8/1998			7/8/1998			7/8/1998			7/8/1998			5/23/2000		
Channel Station:						50+00			50+00			112+00			125+00			75+00		
Parameter	Liquid Media Unit	Solid Media Unit	WQC	TWQS	ERL	Water	Elutriate	Sediment	Water	Elutriate	Sediment	Water	Elutriate	Sediment	Water	Elutriate	Sediment	Water	Elutriate	Sediment
Sand		%						12.1			10.7									
Silt		%						23.8			21.4									
Clay		%						64.1			67.9									
D50		mm						0.00			0.00									
Percent Solids		%																		
Arsenic	µg/L	mg/kg	69	149	8.2	2.40	4.39	7.98	1.20	8.16	7.72	1.50	7.53		1.00	9.10		<1.00	<1.00	
Barium	µg/L	mg/kg	N/A	N/A	N/A	33.5	378.0	124.0	34.1	541.0	199.0	29.6	93.0		22.8	81.3		44.3	52.5	
Cadmium	µg/L	mg/kg	40	45.4	1.20	0.3	<0.1	<0.10	0.4	<0.1	<0.10	0.5	<0.1		0.7	<0.1		0.60	<0.10	
Chromium	µg/L	mg/kg	1,100	1,090	81.0	<1.00	<1.00	10.70	<1.00	<1.00	23.10	<1.00	<1.00		<1.00	<1.00		<1.00	<1.00	
Copper	µg/L	mg/kg	4.8	13.5	34.0	<1.00	<1.00	10.90	<1.00	<1.00	12.10	<1.00	<1.00		<1.00	<1.00		32.30	<1.00	
Lead	µg/L	mg/kg	210	133	46.7	1.60	<1.00	2.85	2.80	<1.00	12.50	2.10	<1.00		2.90	<1.00		<1.00	<1.00	
Mercury	µg/L	mg/kg	1.8	2.1	0.15	<0.20	<0.20	0.11	<0.20	<0.20	<0.02	<0.20	<0.20		<0.20	<0.20		<0.20	<0.20	
Nickel	µg/L	mg/kg	74	118	20.9	<1.00	3.30	12.7	<1.00	<1.00	16.3	2.42	4.10		<1.00	3.30		<1.00	<1.00	
Selenium	µg/L	mg/kg	290	564	N/A	<1.00	<1.00	<0.20	<1.00	<1.00	<0.20	<1.00	<1.00		<1.00	<1.00		<1.00	<1.00	
Silver	µg/L	mg/kg	1.9	2.0	1.00	<1.00	<1.00	<0.10	<1.00	<1.00	<0.10	<1.00	<1.00		<1.00	<1.00		<1.00	<1.00	
Thallium	µg/L	mg/kg	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A		N/A	N/A	
Zinc	µg/L	mg/kg	90	92.7	150	73.4	3.10	47.4	3.10	1.90	55.1	2.10	68.0		8.6	1.50		13.0	4.30	
TOC	mg/L	%	N/A	N/A	N/A	<1.00	<1.00	12500	<1.00	<1.00	8820	<1.00	<1.00		<1.00	<1.00		<1.0	<1.0	
Total PCB	µg/L	ug/kg	N/A	N/A	N/A	<0.01	<0.01	<1.00	<0.01	<0.01	<1.00	<0.01	<0.01		<0.01	<0.01		<0.01	<0.01	
Ammonia	mg/L	mg/kg	Var	N/A	N/A	0.15	14.60	2.11	0.12	14.90	2.79	0.14	10.80		0.09	6.87		<0.03	<0.03	

Chromium = CrIII and Total Cr
Var = varies based on pH, salinity, and temperatures
N/A means that no analyses were conducted for a particular parameter in a particular year
WQC = EPA Acute, Marine Water Quality Criterion; TWQS = Texas Acute, Marine Water Quality Standard; ERL = Effects Range Low

TABLE 3.9-2 (Continued)

DETECTED PARAMETERS
FREEPORT HARBOR CHANNEL

					Station:	FH-H-00-01A			FH-H-00-01B			FH-H-00-01B DUP			FH-J-00-01A			FH-OB-00-05		
					Date:	5/23/2000			5/23/2000			5/23/2000			5/23/2000			5/23/2000		
					Channel Station:	85+00			95+00			95+00			60+00			-150+00		
Parameter	Liquid Media Unit	Solid Media Unit	WQC	TWQS	ERL	Water	Elutriate	Sediment	Water	Elutriate	Sediment	Water	Elutriate	Sediment	Water	Elutriate	Sediment	Water	Elutriate	Sediment
Sand		%															6.7			4.1
Silt		%															21.2			25.8
Clay		%															72.1			70.1
D50		mm															0.00			0.00
Percent Solids		%																		
Arsenic	µg/L	mg/kg	69	149	8.2	<1.00	<1.00		<1.00	<1.00		<1.00	<1.00		<1.00	<1.00	4.38	<1.00	<1.00	4.51
Barium	µg/L	mg/kg	N/A	N/A	N/A	41.9	58.8		50.8	60.0		46.0	55.4		51.0	58.3	104.0	28.2	52.4	55.0
Cadmium	µg/L	mg/kg	40	45.4	1.20	0.90	<0.10		0.60	0.40		0.30	0.90		0.30	<0.10	<0.10	0.70	<0.10	0.10
Chromium	µg/L	mg/kg	1,100	1,090	81.0	<1.00	<1.00		<1.00	<1.00		<1.00	<1.00		<1.00	<1.00	7.66	<1.00	<1.00	7.27
Copper	µg/L	mg/kg	4.8	13.5	34.0	**5.00**	2.90		1.20	2.90		<1.00	<1.00		<1.00	<1.00	7.52	<1.00	2.40	7.86
Lead	µg/L	mg/kg	210	133	46.7	<1.00	<1.00		<1.00	<1.00		<1.00	<1.00		<1.00	<1.00	16.2	<1.00	<1.00	16.0
Mercury	µg/L	mg/kg	1.8	2.1	0.15	<0.20	<0.20		<0.20	<0.20		<0.20	<0.20		<0.20	<0.20	0.04	<0.20	<0.20	0.04
Nickel	µg/L	mg/kg	74	118	20.9	<1.00	<1.00		<1.00	<1.00		<1.00	<1.00		<1.00	<1.00	9.82	<1.00	<1.00	10.20
Selenium	µg/L	mg/kg	290	564	N/A	<1.00	<1.00		<1.00	<1.00		<1.00	<1.00		<1.00	<1.00	0.24	<1.00	<1.00	0.22
Silver	µg/L	mg/kg	1.9	2.0	1.00	<1.00	<1.00		<1.00	<1.00		<1.00	<1.00		<1.00	<1.00	<0.10	<1.00	<1.00	<0.10
Thallium	µg/L	mg/kg	N/A	N/A	N/A	N/A	N/A		N/A	N/A		N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A
Zinc	µg/L	mg/kg	90	92.7	150	8.7	5.5		491.0	6.1		10.7	7.1		14.5	4.6	37.2	6.6	3.3	28.3
TOC	mg/L	%	N/A	N/A	N/A	<1.0	<1.0		<1.0	<1.0		<1.0	<1.0		<1.0	<1.0	16100	<1.0	<1.0	15100
Total PCB	µg/L	ug/kg	N/A	N/A	N/A	<0.01	<0.01		<0.01	<0.01		<0.01	<0.01		<0.01	<0.01	<1.00	<0.01	<0.01	<1.00
Ammonia	mg/L	mg/kg	Var	N/A	N/A	0.12	<0.03		0.11	<0.03		<0.03	<0.03		0.11	<0.03	26.7	<0.03	0.75	3.17

Chromium = CrIII and Total Cr
Var = varies based on pH, salinity, and temperatures
N/A means that no analyses were conducted for a particular parameter in a particular year
WQC = EPA Acute, Marine Water Quality Criterion; TWQS = Texas Acute, Marine Water Quality Standard; ERL = Effects Range Low

TABLE 3.9-2 (Continued)

DETECTED PARAMETERS
FREEPORT HARBOR CHANNEL

					Station:	FH-OB-00-06			FH-OB-00-PA1A			FH-OB-00-REF1			FH-EC-04-01			FH-EC-04-02		
					Date:	5/23/2000			5/23/2000			5/23/2000			4/29/2004			4/29/2004		
					Channel Station:	-200+00									60+00			-45+00		
Parameter	Liquid Media Unit	Solid Media Unit	WQC	TWQS	ERL	Water	Elutriate	Sediment	Water	Elutriate	Sediment	Water	Elutriate	Sediment	Water	Elutriate	Sediment	Water	Elutriate	Sediment
Sand		%						1.0			28.2			6.1			7.5			10.7
Silt		%						29.4			41.6			33.4			28.0			65.5
Clay		%						69.6			30.2			60.5			64.5			23.8
D50		mm						0.00			0.05			0.00			0.00			0.01
Percent Solids		%															40.2			42.6
Arsenic	µg/L	mg/kg	69	149	8.2	<1.00	<1.00	5.77	<1.00		3.43	<1.00	<1.00	4.92	1.83	2.58	6.75	1.32	2.47	7.12
Barium	µg/L	mg/kg	N/A	N/A	N/A	25.2	40.4	106.0	31.7		76.0	26.2	47.5	81.2	N/A	N/A	N/A	N/A	N/A	N/A
Cadmium	µg/L	mg/kg	40	45.4	1.20	<0.10	0.10	<0.10	0.60		<0.10	0.90	0.40	0.10	<1.00	<1.00	<0.10	<1.00	<1.00	<0.10
Chromium	µg/L	mg/kg	1,100	1,090	81.0	<1.00	<1.00	9.66	<1.00		6.00	<1.00	<1.00	8.91	<1.00	<1.00	18.8	<1.00	<1.00	14.9
Copper	µg/L	mg/kg	4.8	13.5	34.0	**8.00**	<1.00	10.00	<1.00		7.53	<1.00	<1.00	9.34	<1.00	<1.00	11.3	<1.00	<1.00	8.55
Lead	µg/L	mg/kg	210	133	46.7	<1.00	<1.00	17.9	<1.00		11.1	<1.00	<1.00	16.1	<1.00	<1.00	17.9	<1.00	<1.00	17.8
Mercury	µg/L	mg/kg	1.8	2.1	0.15	<0.20	<0.20	0.04	<0.20		0.04	<0.20	<0.20	0.04	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Nickel	µg/L	mg/kg	74	118	20.9	<1.00	<1.00	13.30	4.00		8.04	<1.00	<1.00	12.50	<1.00	<1.00	17.3	<1.00	<1.00	14.9
Selenium	µg/L	mg/kg	290	564	N/A	<1.00	<1.00	0.29	<1.00		0.20	<1.00	<1.00	0.27	<2.00	<2.00	<0.50	<2.00	<2.00	<0.50
Silver	µg/L	mg/kg	1.9	2.0	1.00	<1.00	<1.00	<0.10	<1.00		<0.10	<1.00	<1.00	<0.10	<1.00	<1.00	<0.20	<1.00	<1.00	<0.20
Thallium	µg/L	mg/kg	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	<1.00	<1.00	0.27	<1.00	<1.00	0.21
Zinc	µg/L	mg/kg	90	92.7	150	80.7	4.1	38.5	10.7		31.2	47.1	5.2	34.3	8.39	9.70	28.6	4.61	8.72	27.3
TOC	mg/L	%	N/A	N/A	N/A	<1.0	<1.0	18800	<1.0		10100	<1.0	<1.0	15500	4.32	8.34	7800	3.07	5.33	7800
Total PCB	µg/L	ug/kg	N/A	N/A	N/A	<0.01	<0.01	<1.00	<0.01		<1.00	<0.01	<0.01	<1.00	N/A	N/A	N/A	N/A	N/A	N/A
Ammonia	mg/L	mg/kg	1.7	N/A	N/A	<0.03	0.70	12.4	<0.03		29.0	<0.03	0.36	3.05	0.05	1.17	99.9	0.03	1.25	88.6

Chromium = CrIII and Total Cr
Var = varies based on pH, salinity, and temperatures
N/A means that no analyses were conducted for a particular parameter in a particular year
WQC = EPA Acute, Marine Water Quality Criterion; TWQS = Texas Acute, Marine Water Quality Standard; ERL = Effects Range Low

TABLE 3.9-2 (Continued)

DETECTED PARAMETERS
FREEPORT HARBOR CHANNEL

					Station:	FH-EC-04-03			FH-EC-04-03 DUP			FH-EC-04-REF			FH-EC-05-01			FH-EC-05-02		
					Date:	4/29/2004			4/29/2004			4/29/2004			6/29/2005			6/29/2005		
					Channel Station:	-150+00			-150+00						60+00			-45+00		
Parameter	Liquid Media Unit	Solid Media Unit	WQC	TWQS	ERL	Water	Elutriate	Sediment	Water	Elutriate	Sediment	Water	Elutriate	Sediment	Water	Elutriate	Sediment	Water	Elutriate	Sediment
Sand		%						1.1			0.9			12.9			4.0			16.7
Silt		%						68.0			63.6			28.2			19.1			41.5
Clay		%						30.9			35.5			58.9			76.9			41.8
D50		mm						0.01			0.01			0.00			0.00			0.01
Percent Solids		%						35.4			33.5			47.2			41.4			45.8
Arsenic	µg/L	mg/kg	69	149	8.2	1.30	1.45	**8.63**	1.80	1.07	**9.15**			6.93	2.25	3.84	7.26	2.26	4.08	6.19
Barium	µg/L	mg/kg	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A			N/A	N/A	N/A	N/A	N/A	N/A	N/A
Cadmium	µg/L	mg/kg	40	45.4	1.20	<1.00	<1.00	<0.10	<1.00	<1.00	<0.10			0.13	<1.00	<1.00	<0.10	<1.00	<1.00	<0.10
Chromium	µg/L	mg/kg	1,100	1,090	81.0	<1.00	<1.00	19.3	<1.00	<1.00	20.5			19.6	<1.00	<1.00	23.5	<1.00	<1.00	18.7
Copper	µg/L	mg/kg	4.8	13.5	34.0	<1.00	<1.00	11.2	<1.00	<1.00	11.8			12.2	<1.00	<1.00	14.0	<1.00	<1.00	10.4
Lead	µg/L	mg/kg	210	133	46.7	<1.00	<1.00	22.5	<1.00	<1.00	23.7			17.6	<1.00	<1.00	18.5	<1.00	<1.00	15.2
Mercury	µg/L	mg/kg	1.8	2.1	0.15	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20			<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Nickel	µg/L	mg/kg	74	118	20.9	<1.00	<1.00	18.6	<1.00	<1.00	19.3			18.8	<1.00	6.06	19.2	<1.00	3.89	15.8
Selenium	µg/L	mg/kg	290	564	N/A	<2.00	<2.00	<0.50	<2.00	<2.00	<0.50			<0.50	2.26	<2.00	<0.50	2.24	<2.00	<0.50
Silver	µg/L	mg/kg	1.9	2.0	1.00	<1.00	<1.00	<0.20	<1.00	<1.00	<0.20			<0.20	<1.00	<1.00	<0.20	<1.00	<1.00	<0.20
Thallium	µg/L	mg/kg	N/A	N/A	N/A	<1.00	<1.00	0.28	<1.00	<1.00	0.27			0.21	<1.00	<1.00	1.09	<1.00	<1.00	0.50
Zinc	µg/L	mg/kg	90	92.7	150	12.2	8.61	31.0	2.83	8.04	34.1			25.4	<1.00	5.03	19.6	<1.00	1.89	17.1
TOC	mg/L	%	N/A	N/A	N/A	3.33	3.98	11300	3.71	3.95	11500			10300	2.80	3.37	14800	3.25	4.29	15300
Total PCB	µg/L	ug/kg	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A			N/A	N/A	N/A	N/A	N/A	N/A	N/A
Ammonia	mg/L	mg/kg	1.7	N/A	N/A	0.03	0.55	83.5	0.03	0.72	82.8			71.0	0.15	0.87	17.2	0.11	0.74	7.7

Chromium = CrIII and Total Cr
Var = varies based on pH, salinity, and temperatures
N/A means that no analyses were conducted for a particular parameter in a particular year
WQC = EPA Acute, Marine Water Quality Criterion; TWQS = Texas Acute, Marine Water Quality Standard; ERL = Effects Range Low

TABLE 3.9-2 (Concluded)

DETECTED PARAMETERS
FREEPORT HARBOR CHANNEL

					Station:	FH-EC-05-02 DUP			FH-EC-05-03			FH-EC-05-REF		
					Date:	6/29/2005			6/29/2005			6/29/2005		
					Channel Station:	-45+00			-150+00					
Parameter	Liquid Media Unit	Solid Media Unit	WQC	TWQS	ERL	Water	Elutriate	Sediment	Water	Elutriate	Sediment	Water	Elutriate	Sediment
Sand		%						14.5			1.0			7.5
Silt		%						47.8			70.2			5.7
Clay		%						37.7			28.8			86.8
D50		mm						0.01			0.01			0.00
Percent Solids		%						43.1			33.7			47.4
Arsenic	µg/L	mg/kg	69	149	8.2	2.34	3.78	6.47	2.42	3.10	**8.61**			7.53
Barium	µg/L	mg/kg	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A			N/A
Cadmium	µg/L	mg/kg	40	45.4	1.20	<1.00	<1.00	<0.10	<1.00	<1.00	<0.10			0.2
Chromium	µg/L	mg/kg	1,100	1,090	81.0	<1.00	<1.00	18.7	<1.00	<1.00	23.6			23.8
Copper	µg/L	mg/kg	4.8	13.5	34.0	<1.00	<1.00	10.3	<1.00	<1.00	13.9			15.4
Lead	µg/L	mg/kg	210	133	46.7	<1.00	1.27	16.1	<1.00	1.19	21.7			16.8
Mercury	µg/L	mg/kg	1.8	2.1	0.15	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20			<0.20
Nickel	µg/L	mg/kg	74	118	20.9	<1.00	4.34	16.0	<1.00	4.35	19.9			20.8
Selenium	µg/L	mg/kg	290	564	N/A	2.26	<2.00	<0.50	2.21	<2.00	<0.50			<0.50
Silver	µg/L	mg/kg	1.9	2.0	1.00	<1.00	<1.00	<0.20	<1.00	<1.00	<0.20			<0.20
Thallium	µg/L	mg/kg	N/A	N/A	N/A	<1.00	<1.00	0.28	<1.00	<1.00	0.53			0.38
Zinc	µg/L	mg/kg	90	92.7	150	<1.00	2.40	17.4	<1.00	2.29	24.1			17.9
TOC	mg/L	%	N/A	N/A	N/A	1.87	5.49	12900	2.28	4.13	18900			13300
Total PCB	µg/L	ug/kg	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A			N/A
Ammonia	mg/L	mg/kg	2.9	N/A	N/A	0.19	1.07	21.2	0.16	0.98	20.6			12.2

Chromium = CrIII and Total Cr
Var = varies based on pH, salinity, and temperatures
N/A means that no analyses were conducted for a particular parameter in a particular year
WQC = EPA Acute, Marine Water Quality Criterion; TWQS = Texas Acute, Marine Water Quality Standard; ERL = Effects Range Low

441591/060111

TABLE 3.9-3
CONSTITUENTS DETECTED IN WATER AND ELUTRIATE SAMPLES BY YEAR

	Year																					
	1987		1988		1989		1993		1995		1997		1998		1999		2000		2004		2005	
Parameter	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E
Arsenic												X	X	X	X	X			X	X	X	X
Barium									X	X	X	X	X	X	X	X	X	X				
Cadmium			X	X					X	X	X		X	X	X		X	X				
Chromium								X			X		X	X								
Copper	X	X									X	X	X	X			X	X				
Lead	X	X										X			X							X
Mercury											X											
Nickel			X	X							X	X		X	X	X						X
Selenium												X									X	
Silver																						
Thallium																						
Zinc	X	X	X	X			X	X			X	X	X		X	X	X	X	X	X		X
TOC													X	X					X	X	X	X
Total PCB																						
Ammonia											X	X		X	X	X	X		X	X	X	X

* Channel Stations Only, PA and Reference samples are not included.

W = water, E = elutriate

of high cadmium concentrations was also true of the sediments: pre- and post-1995, no value was above 1.5 milligram per kilogram (mg/kg), while in 1995 the values ranged from 134.6 mg/kg to 329.1 mg/kg. Mercury, selenium, and total PCBs were also high in the sediment samples in 1995, relative to the other years but they were not detected in the water or elutriate samples. Additionally, chromium, nickel, and zinc were abnormally low in the sediments. Whatever the explanation for these data, they were not repeated in the five data sets since then.

For samples collected in January 1997, the copper WQC but not TWQS, was exceeded in one water and three elutriate samples. In September 1997 samples, copper was not detected in any elutriate samples and in only one water sample. There were no other exceedances in 1997. Analyses for ammonia were first conducted in 1997 and continue to the present. There is no TWQS for ammonia but there is a WQC. However, it is based on a combination of temperature, salinity, and pH and, thus, varies from sample to sample. For more recent data (2004 and 2005), where all of these parameters are available, the WQC was calculated and is compared to the water and elutriate concentrations. Samples were also collected at two different times in 1998. More constituents were detected in the March samples than in the September samples (see Table 3.9-3) but there were no exceedances of any WQC or TWQS.

For samples collected in 2000, the copper WQC but not TWQS, was exceeded in two water samples: one in the Brazosport Turning Basin and one in the Entrance Channel. Copper was not detected or was below the WQC and TWQS in the rest of the water samples and in all elutriate samples. There were no other exceedances in 2000. In 2004 and 2005, the latest data sets and the only ones within the last five years, there were no consistent trends when elutriate concentrations were compared to water concentrations except that elutriate ammonia values were always higher than water ammonia values. No WQC or TWQS was exceeded in 2004 or 2005 samples.

3.9.2.3 Bioassays

Two recent sets of elutriate bioassays have been conducted on samples collected from the Entrance Channel (PBS&J 1999, 2004). The results of these tests are presented in Table 3.9-4, an examination of which indicates that in all tests, survival of organisms exposed to the suspended particulate phase (SPP, unfiltered elutriate) of sediments from the Freeport Harbor Jetty and Entrance Channels was greater than 50%, and in all instances except one, above 90%. Therefore, no 96 hour LC_{50} (that concentration of a substance which is lethal to 50% of test organisms after a continuous exposure time of 96 hours) could be calculated. This indicates that no acute toxicity to water column organisms could be expected from dredging the Jetty and Entrance Channels or placement of Channel sediments.

There are no indications of water or elutriate problems in the Freeport Harbor Jetty and Entrance Channels.

TABLE 3.9-4
THE NUMBER AND PERCENTAGES OF SURVIVING ORGANISMS
SUSPENDED PARTICULATE PHASE BIOASSAYS
100% TEST SOLUTION
April 1999

		Number of Survivors							
	Replicate	True Control	Reference Control	True Control	FH-1	True Control	FH-2	True Control	FH-3
A. bahia	1	10	9	10	9	10	9	10	10
juveniles	2	10	9	10	9	10	10	10	10
10/replicate	3	10	10	10	9	10	10	10	9
	4	10	8	10	10	10	10	10	10
	5	9	10	9	9	9	9	9	10
	Average	9.8	9.2	9.8	9.2	9.8	9.6	9.8	9.8
	(%)	98.0%	92.0%	98.0%	92.0%	98.0%	96.0%	98.0%	98.0%
A. bahia	1	10	10	10	10	10	10	10	9
adults	2	10	10	10	9	10	10	10	7
10/replicate	3	10	10	10	10	10	10	10	6
	4	10	9	10	10	10	10	10	9
	5	10	10	10	10	10	9	10	7
	Average	10.0	9.8	10.0	9.8	10.0	9.8	10.0	7.6
	(%)	100.0%	98.0%	100.0%	98.0%	100.0%	98.0%	100.0%	76.0%
C. variegatus	1	10	10	10	10	10	10	10	10
10/replicate	2	10	10	10	10	10	10	10	10
	3	10	10	10	10	10	10	10	10
	4	10	10	10	10	10	10	10	10
	5	9	10	9	10	9	10	9	10
	Average	9.8	10.0	9.8	10.0	9.8	10.0	9.8	10.0
	(%)	98.0%	100.0%	98.0%	100.0%	98.0%	100.0%	98.0%	100.0%

TABLE 3.9-4 (Concluded)
THE NUMBER AND PERCENTAGES OF SURVIVING ORGANISMS
SUSPENDED PARTICULATE PHASE BIOASSAYS
100% TEST SOLUTION
May 2004

		Number of Survivors							
	Replicate	Dilution Control	Reference Control	Dilution Control	FH-EC-01 60+00	Dilution Control	FH-EC-02 -45+00	Dilution Control	FH-EC-03 -150+00
A. bahia	1	10	10	10	10	10	10	10	10
juveniles	2	10	10	10	10	10	10	10	10
10/replicate	3	10	10	10	10	10	10	9	10
	4	10	10	10	10	10	10	10	10
	5	10	10	10	10	10	10	10	10
	Average	10.0	10.0	10.0	10.0	10.0	10.0	9.8	10.0
	(%)	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	98.0%	100.0%
A. bahia	1	10	10	10	10	10	10	10	10
adults	2	10	9	10	10	10	10	10	10
10/replicate	3	10	10	10	10	10	9	10	10
	4	10	10	10	10	10	10	10	10
	5	10	9	10	10	10	10	10	10
	Average	10.0	9.6	10.0	10.0	10.0	9.8	10.0	10.0
	(%)	100.0%	96.0%	100.0%	100.0%	100.0%	98.0%	100.0%	100.0%
M. beryllina	1	10	10	10	10	10	10	10	10
10/replicate	2	6	10	6	10	6	9	6	10
	3	10	10	10	10	10	10	10	10
	4	10	10	10	10	10	9	10	10
	5	10	10	10	9	10	10	10	9
	Average	9.2	10.0	9.2	9.8	9.2	9.6	9.2	9.8
	(%)	92.0%	100.0%	92.0%	98.0%	92.0%	96.0%	92.0%	98.0%

3.9.2.4 Ballast Water

Ballast water is loaded on empty ships to provide weight and stability while traveling from one port to the next. There are thousands of marine species that can be carried from port to port in ballast water which may ultimately result in the introduction of unwanted aquatic species from foreign ports of origin (Global Ballast Water Management Programme, 2006). As a consequence, invasive, exotic species have been introduced into United States waters through ballast water. Ballast water is the largest single vector for nonindigenous species transfer (EPA, 2001). The EPA has compiled a list of invasive species that have the potential to be unintentionally introduced in Texas, although not necessarily through ballast water alone (Table 3.9-5) (EPA, 2001).

The USCG, under the provisions of the National Invasive Species Act of 1996, has implemented a program that consists of a suite of mandatory ballast water management (BWM) protocols. All vessels, foreign and domestic, equipped with ballast water tanks that operate within the U.S. waters are required to comply with 33 CFR Part 151 regarding management protocol. This includes submitting a ballast water exchange report to the National Ballast Information Clearinghouse (NBIC) to ensure compliance with the management requirements (USCG, 2006a).

According to the NBIC (2006) ballast water reporting database, between 2004 and 2006, 271 ballast water exchange reports were submitted for Freeport Harbor. Of these, 14 represented treated and 8 represented untreated discharges that occurred at Freeport. Treated discharges consisted of either flow-through or empty/refill of ballast tanks.

3.9.3 Sediment Quality

3.9.3.1 Surficial Sediments

There has been only one recent study that evaluated construction material, as part of the jetty stability analysis, which is pertinent to the project (PBS&J, 2005). Soil samples were collected by Fugro (2005) to determine if the soils presented a “cause for concern”. There are no sediment or soil quality criteria with which to compare concentrations in soils; however, there are several different guidelines that are used to look for a cause for concern in sediment samples. One of these guidelines is the ERL, which has been used in the past to examine both soils and sediments destined for BU or ocean disposal in the Gulf of Mexico.

It should be noted that while ERLs are used for comparative purposes, they were developed by assembling a large group of sediment data sets, comprising samples for which there was both bulk sediment chemistry and exhibition of toxicity. For each chemical in the data set, the concentrations were ranked in ascending order and the ERL was calculated as the lower 10th percentile of the concentrations. However, this approach demonstrates no cause and effect from the chemicals in the data set, since the fact that a chemical was detected does not demonstrate that it was responsible for any of the toxicity exhibited by the sediment. Not surprisingly, when ERLs derived from sets of data from different areas are

TABLE 3.9-5
CURRENT AND POTENTIAL AQUATIC SPECIES
THAT POSE A THREAT TO TEXAS

Scientific Name	Common Name	Texas
Shrimp Viruses		
Taura Syndrome Virus	shrimp virus	√
White Spot Syndrome Virus	shrimp virus	√
Coelenterates		
Phyllorhiza punctata	spotted jellyfish	P
Roundworms (phylum Nematoda)		
Anguillicola crassus	eel parasite	P
Mollusks		
Corbicula fluminea	Asian clam	P
Crassostrea gigas	Japanese (or Pacific giant) oyster	√
Dreissena polymorpha	zebra mussel	P
Perna perna	brown mussel	P
Pomacea canalicula	channeled applesnail	√
Crustaceans		
Carcinus maenus	green crab	P
Charybdis helleri	marine swimming crab	P
Eriocheri sinensis	Chinese mittencrab	P
Fishes		
Cichlasoma cyanoguttatum	Rio Grande cichlid	√
Ctenopharyngodon idella	grass carp	√
Hypophthalmichthys molitrix	silver carp	P
Hypophthalmichthys nobilis	bighead carp	P
Mylopharyngodon piceus	black carp	P
Oreochromis aureus	blue tilapia	√
Oreochromis mossambicua	Mozambique tilapia	√
Mammals		
Myocastor coypus	nutria	√
Algae		
Aureoumbra lagunensis	brown tide algae	√*

TABLE 3.9-5
CURRENT AND POTENTIAL AQUATIC SPECIES
THAT POSE A THREAT TO TEXAS

Scientific Name	Common Name	Texas
Vascular Plants		
Alternathera philoxeroides	alligatorweed	√
Eichhornia crassipes	water hyacinth	√
Hydrilla verticillata	hydrilla	√
Ipomoea aquatica	waterspinach	P
Lythrum salicaria	purple loosestrife	P
Panicum repens	torpedograss	√
Pistia stratiotes	waterlettuce	√
Salvinia minima	common salvinia	√
Salvinia molesta	giant salvinia	√
Semi-Aquatic Vascular Plants		
Pueraria montana	kudzu	P
Sapium sebiferum	Chinese tallow tree	√

P = Potential threat
√ = Current threat
* = Cryptogenic (a species whose status as indigenous or nonindigenous remains unresolved)

Source: EPA, 2001

compared, the results are inconsistent (USACE, 1998). For example, when the ERLs of a number of chemicals were compared using a northern California data set versus a southern California data set, the ERLs differed by a range, from only a factor of three for total polychlorinated biphenyls (PCB) to a factor of 2,689 for p,p' DDE. Since the ERLs are not based on cause and effect data, one would expect them to exhibit low predictive ability and to give a high number of false positives, both of which are true (USACE, 1998). Also used, on occasion, are the Effects Range Medium (ERM), similar to the ERLs but with higher concentrations. The ERLs (and the one ERM) used here are those presented in the National Oceanic and Atmospheric Administration (NOAA) 1999 Screening Quick Reference Tables (Buchman, 1999).

Data for detected compounds are presented in Table 3.9-6: a total of ten samples taken from six borings (Figure 3.9-1). Arsenic, beryllium, total chromium, copper, lead, manganese, mercury, nickel, and zinc were detected in all samples. Thallium was detected in 6 of 10 samples, mercury in only 2 samples. Antimony, cadmium, selenium, silver, and the nonmetal, cyanide, were not detected in any sample.

A complete suite of organic compound analyses were conducted including organic halides, VOCs, semivolatile organic compounds, pesticides, and PCBs. Of these, only fluoranthene was detected and in only one sample.

There were six exceedances of ERLs: all by nickel, ranging from 23.8 mg/kg (114% of the ERL) to 35.3 mg/kg (170% of the ERL). Nickel concentrations up to 28.6 mg/kg were found in sediments from the Sabine-Neches Entrance Channel (PBS&J, 1999), but no toxicity was exhibited by sensitive water column or benthic organisms, during bioassays conducted according to procedures provided in EPA/USACE (1991). Since (1) there is no way to determine if nickel was the causative factor in the data that led to the nickel ERL, (2) toxicity data have demonstrated that nickel concentrations in the same range as those found in these samples did not cause toxicity, (3) the concentrations are less than a factor of two of the ERL, (4) the concentrations are below the ERM concentration (51.6 mg/kg) and well below the Apparent Effects Threshold values, of which 110.0 mg/kg (for echinoderm larvae) is the lowest value (Buchman, 1999), (5) there are no-action levels established by the food and drug administration for poisonous or deleterious substances in human food and animal feed (which includes fish and shellfish) for nickel, and (6) no other ERLs were exceeded, there would appear to be no significant cause for concern relative to placing these soils in the Gulf of Mexico or using them beneficially.

3.9.3.2 Maintenance Material

3.9.3.2.1 Chemistry

The data, collected by the USACE on maintenance material and others since 1987, were analyzed to determine the sediment quality of the project area. The data presented here are from bulk sediment analyses, which tend to show considerable variation, even within duplicates. The data from areas outside the Jetty and Entrance channels are not included in this analysis because those sediments will not be part of the maintenance material from the widened channel. Like the construction material discussed above, the sediment data are compared to ERLs.

TABLE 3.9-6

CONCENTRATIONS OF DETECTED CONSTITUENTS IN SOILS (dry weight)

FREEPORT WIDENING PROJECT

Date Sampled: February 2005

Parameter	Units	NOAA ERL*	B-1,E,26' 0211038	B-2,E-1,24' 0211039	B-2,E-2,46' 0211040	B-3,E-1,26' 0211041	B-3,E-2,35' 0211042	B-4,E-1,35' 0211043	B-4,E-2,40' 0211044	B-5,E-1,34' 0211045	B-5,E-2,59' 0211046	B-6,E-2,32-34' 0211047
Antimony	mg/kg	N/A	< 0.0986	< 0.0934	< 0.0971	< 0.0948	< 0.0977	< 0.0977	< 0.0971	< 0.0878	< 0.0910	< 0.0966
Arsenic	mg/kg	8.2	2.7	2.4	1.4	0.700	8.2	2.0	4.1	0.600	2.0	1.6
Beryllium	mg/kg	N/A	1.15	1.18	1.46	0.274	1.46	0.743	1.16	0.142	0.983	0.433
Chromium, Total	mg/kg	81.0	28.1	46.0	59.9	7.8	46.8	15.3	23.2	4.1	20.2	9.9
Copper	mg/kg	34.0	25.8	19.1	19.9	3.6	26.1	10.1	19.5	1.6	12.2	4.6
Lead	mg/kg	46.7	14.9	27.6	29.9	5.1	39.9	7.0	15.6	2.8	10.7	6.8
Manganese	mg/kg	N/A	257.7	184.7	214.1	130.2	723.2	157.2	489.6	85.2	290.1	311.9
Mercury	mg/kg	0.150	< 0.00794	< 0.00664	< 0.00663	< 0.00613	< 0.00647	< 0.00597	< 0.00647	< 0.00602	0.0111	0.0129
Nickel	mg/kg	20.9	**30.2**	**26.8**	**33.3**	6.0	**35.3**	17.6	**29.8**	3.3	**23.8**	10.6
Thallium	mg/kg	N/A	0.294	0.284	0.340	< 0.190	0.324	< 0.195	0.285	< 0.176	0.214	< 0.193
Zinc	mg/kg	150	61.7	63.1	73.5	38.0	64.5	34.8	58.9	10.5	50.4	40.6
Fluoranthene	ug/kg	600	< 635	< 531	< 265	534	< 259	< 239	< 259	< 241	< 237	< 259
Percent Solids	%	N/A	63.0	75.3	75.4	81.5	77.3	83.8	77.3	83.0	84.5	77.1

ERL = Effects Range Low for Marine Sediments. There are no ERLs for soils.

PBS&J
6504 Bridge Point Pkwy, Ste. 200
Austin, Texas 78730
Phone: (512) 329-8342 Fax: (512) 327-2453

Figure 3.9-1
Fugro Boring Locations, Port Freeport

Prepared for: USACE, Galveston District	
Job No.: 441591.00	Scale: 1:30,000
Prepared by: EMonshaugen	Date: 06/07/2006
File: N:/44159100/Projects/Fig3_9_1.mxd	

Geotechnical Boring

N
W E
S

2,500 1,250 0 2,500
Feet

Source: Fugro Consultants, 2005.

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The sediment chemistry data is presented in Table 3.9-2 for the same time period and the same stations as for the water and elutriate samples, except, as noted above, channel stations outside of the project area are not included. PA stations and Reference station data are included in Table 3.9-2 for comparison purposes. Exceedances of ERLs are bolded in Table 3.9-2. Table 3.9-7 shows the years in which the various constituents in Table 3.9-2 were detected, but only in channel station sediments.

There were no exceedances of ERLs in 1987, 1988, or 1989. In 1993, the ERL for cadmium was slightly exceeded in two of seven samples. For example, the Reference concentration was 1.0 mg/kg, the ERL is 1.2 mg/kg, and the highest concentration was 1.5 mg/kg. In 1995, as noted in the discussion on water and elutriates, sediment cadmium ranged up to 244.6 mg/kg, over 200 times the ERL, and exceeded the ERL in all Jetty and Entrance Stations. The ERL was also exceeded at the PA and Reference stations. Mercury also exceeded the ERLs in 1995 at all channel stations, the PA, and the Reference station. The ERL for mercury was exceeded by more than 100 times in the PA sample, which contained the highest concentration of mercury. There are no ERLs for selenium and total PCBs but these constituents were also found in very high concentrations in all sediment samples, relative to concentrations in other years. The fact that the concentrations were high in the PA samples, where placement had not yet taken place in the 1995 dredging cycle and the Reference sample calls these data into question.

In January 1997, the nickel ERL was slightly exceeded (1.2 times maximum) in all Entrance channel sediment samples and the PA sample but not the Jetty Channel or Reference samples. The lead ERL was also slightly exceeded (1.02 times) at one station. There were no exceedances in September 1997 or in March 1998. In September 1998, the mercury ERL was slightly exceeded (0.21 mg/kg versus and ERL of 0.15 mg/kg) at one Entrance Channel station. There were no exceedances in 1999 or 2000. In 2004, the ERL for arsenic was slightly exceeded (8.63 and 9.15 mg/kg versus the ERL of 8.2 mg/kg) at one Entrance Channel station and its duplicate. There were no exceedances in 2005.

3.9.3.2.2 Bioassays

Table 3.9-8 presents the data for solid phase (SP, or whole mud) bioassays with Jetty and Entrance Channel sediments from 1999, 2004, and 2005. These bioassays were conducted according to protocols in EPA/USACE (1991) and the Regional Implementation Agreement (RIA) (EPA/USACE, 2003). In 1999, all survival was good and there were no tests in which survival in the Reference Control was greater than survival in the treatments and the difference exceeded 10%, requiring statistical analysis. Therefore, the survival data from the SP bioassay indicate no potential for environmentally unacceptable toxic impacts to benthic organisms from the placement of sediments from Freeport Harbor-Entrance Channel (FH-EC).

Survival in the SP bioassays conducted with the amphipod, *Leptocheirus plumulosus*, on samples collected in April 2004, was acceptable and survival in the Reference Control was not at least 10% greater than survival in the treatments. However, survival of the opossum shrimp, *Americamysis bahia*, was poor, especially in the Reference Control. While the tests theoretically passed the requirements of the RIA, the results were not typical and the SP bioassays with *A. bahia* was repeated in 2005. As can be seen from Table 3.9-8, survival was good for all test groups. Survival was also nearly equal in all tests, confirming

TABLE 3.9-7
CONSTITUENTS DETECTED IN SEDIMENT SAMPLES BY YEAR*

Parameter	1988	1989	1993	1995	1997	1998	1999	2000	2004	2005
Arsenic	X				X	X	X	X	X	X
Barium					X	X	X	X		
Cadmium			X	X		X		X		
Chromium	X	X	X		X	X	X	X	X	X
Copper	X	X	X	X	X	X	X	X	X	X
Lead	X	X	X	X	X	X	X	X	X	X
Mercury				X	X	X	X	X		
Nickel	X	X	X		X	X	X	X	X	X
Selenium				X				X		
Silver						X				
Thallium									X	X
Zinc	X	X	X		X	X	X	X	X	X
TOC						X	X	X	X	X
Total PCB				X						
Ammonia					X	X	X	X	X	X

* Channel Stations in the Project Area Only, PA, Reference, and interior samples are not included.

TABLE 3.9-8
THE NUMBER AND PERCENTAGES OF SURVIVING ORGANISMS
10-DAY SOLID PHASE BIOASSAYS
FREEPORT HARBOR JETTY AND ENTRANCE CHANNELS

1999

		Number of Survivors				
	Replicate (n=5)	True Control	Reference Control	FH-1	FH-2	FH-3
A. abdita	1	19	20	17	17	18
20/replicate	2	17	19	19	17	20
	3	18	20	17	19	18
	4	18	20	19	20	18
	5	19	20	20	19	18
	Average	18.2	19.8	18.4	18.4	18.4
	(%)	91.0%	99.0%	92.0%	92.0%	92.0%
P. pugio	1	18	19	17	19	20
20/replicate	2	20	20	19	18	18
	3	19	20	17	19	17
	4	20	18	20	20	19
	5	19	18	18	18	19
	Average	19.2	19.0	18.2	18.8	18.6
	(%)	96.0%	95.0%	91.0%	94.0%	93.0%
Total Organisms	1	37	39	34	36	38
30/replicate	2	37	39	38	35	38
	3	37	40	34	38	35
	4	38	38	39	40	37
	5	38	38	38	37	37
	Average	37.4	38.8	36.6	37.2	37.0
	(%)	93.5%	97.0%	91.5%	93.0%	92.5%

TABLE 3.9-8 (Continued)

2004

	Replicate (n=5)	Number of Survivors True Control	Reference Control	FH-EC-01 60+00	FH-EC-02 -45+00	FH-EC-03 -150+00
10-DAY	1	20	19	19	20	20
L. plumulosis	2	20	15	18	12	19
20/replicate	3	20	19	19	20	20
	4	20	19	18	9	18
	5	20	15	15	16	8
	Average	20.0	17.4	17.8	15.4	17.0
	(%)	100.0%	87.0%	89.0%	77.0%	85.0%
A. bahia	1	20	6	19	18	20
20/replicate	2	20	16	20	15	17
	3	18	3	19	19	10
	4	19	0	18	7	17
	5	18	12	15	8	15
	Average	19.0	7.4	18.2	13.4	15.8
	(%)	95.0%	37.0%	91.0%	67.0%	79.0%
Total Organisms	1	40	25	38	38	40
30/replicate	2	40	31	38	27	36
	3	38	22	38	39	30
	4	39	19	36	16	35
	5	38	27	30	24	23
	Average	39.0	24.8	36.0	28.8	32.8
	(%)	97.5%	62.0%	90.0%	72.0%	82.0%

2005

	Replicate (n=5)	Number of Survivors True Control	Reference Control	FH-EC-05-01 60+00	FH-EC-05-02 -45+00	FH-EC-05-03 -150+00
10-DAY	1	19	15	17	18	17
A. bahia	2	19	18	17	13	20
20/replicate	3	19	18	15	17	17
	4	20	20	17	20	20
	5	19	18	20	18	19
	Average	19.2	17.8	17.2	17.2	18.6
	(%)	96.0%	89.0%	86.0%	86.0%	93.0%

TABLE 3.9-8 (Concluded)

2003

	Replicate (n=5)	Number of Survivors: True Control	Reference	Q1 NW Quadrant	Q2 NE Quadrant
10-DAY	A	15	17	15	17
A. abdita	B	19	17	18	13
20/replicate	C	17	18	13	18
	D	17	18	17	19
	E	18	17	14	18
	Average	17.2	17.4	15.4	17.0
	(%)	86.0%	87.0%	77.0%	85.0%

	Replicate (n=5)	Number of Survivors: Q3 SE Quadrant	Q4 SW Quadrant	Down Current	LA-5 Control
10-DAY	A	17	18	16	16
A. abdita	B	16	18	17	16
20/replicate	C	17	16	20	13
	D	19	18	18	18
	E	16	19	18	18
	Average	17.0	17.8	17.8	16.2
	(%)	85.0%	89.0%	89.0%	81.0%

the conclusions drawn from the SP bioassay with the April 2004 samples, that there is no indication of a cause for concern from the ocean placement of the maintenance material from FH-EC.

Solid phase bioassays, using the amphipod, *Ampelisca abdita*, were also conducted for the EPA in 2003 (Battelle, 2004). The data reported in Battelle (2004) are also included in Table 3.9-8. These bioassays were on composite sediment samples from the four quadrants of the ODMDS, from a reference area roughly 2 miles up-current from the ODMDS, from an area roughly 750 ft down current of the down-current edge of the ODMDS, and two laboratory controls. Survival ranged from 77% to 89%. There were no tests in which survival in the Reference Control was greater than survival in the treatments and the difference exceeded 10%, requiring statistical analysis.

3.9.3.2.3 Bioaccumulation Studies

Bioaccumulation studies were also conducted on samples of the maintenance material for the USACE and from the Battelle stations noted above for the SP bioassays (Table 3.9-9). In 1999, no organic chemicals were found above detection limits in test organism tissues. Of the metals, arsenic, barium, chromium, copper, lead, nickel, selenium, silver, thallium, and zinc were found in tissue samples above detection limits. Only the concentrations of nickel in tissues of *N. virens* exposed to test sediments were significantly higher than the concentrations in Reference Control organisms. However, the nickel concentration in archive polychaete tissues were more than twice that of the highest test sediment organism, so there was no bioaccumulation, just less depuration in some test polychaetes than in Reference Control polychaetes.

In 2004, no organic chemicals were found above detection limits in test organism tissues, except bis (2-ethylhexyl) phthalate. Of the metals, antimony, arsenic, chromium, copper, lead, mercury, nickel, selenium, silver, thallium, and zinc were found in tissue samples above detection limits. The concentrations of none of the constituents in tissues of *N. virens* or *M. mercenaria* exposed to test sediments were significantly higher than the respective concentrations in Reference Control organisms.

The data reported in Battelle (2004) are also included in Table 3.9-9. These bioaccumulation studies, using *M. nasuta*, were on the composite sediment samples from the four quadrants of the ODMDS, the reference area, the down-current station, and three laboratory controls. Samples were also taken from clams that were not tested (archive samples). In general, all of the values were approximately the same for individual constituents, although the archive tissue tended to have the highest numerical values. “There were no environmentally noteworthy elevations of” metals or organic compounds “in tissues exposed to sediments from the active discharge quadrants (Q1 and Q2), the inactive quadrants (Q3 and Q4), the Down Current site, or the Reference site” (Battelle, 2004).

3.10 COMMERCIAL AND RECREATIONAL NAVIGATION

The Port of Freeport primarily handles bulk fuels and chemicals. Table 3.10-1, summarizing the USACE Waterborne Commerce data, indicates that approximately 81% of the tonnage through the Port consists of

TABLE 3.9-9
AVERAGE CONCENTRATIONS OF DETECTED COMPOUNDS
IN TISSUE SAMPLES OF
FREEPORT HARBOR JETTY AND ENTRANCE CHANNELS

N. virens 1999

Parameter	STATION					
	True Control	Reference Control	FH-1	FH-2	FH-3	Archive
Metals (mg/kg)						
Arsenic	1.17	0.64	0.74	0.76	0.85	1.03
Barium	0.59	0.53	0.69	0.52	0.63	0.49
Cadmium	0.10	0.10	0.18	0.10	0.10	0.10
Chromium	0.25	0.49	0.36	0.49	0.55	1.53
Copper	5.22	9.80	3.24	4.36	8.34	4.26
Lead	0.10	0.10	0.12	0.10	0.18	0.11
Nickel	0.67	0.54	0.67	1.01	1.22	2.44
Selenium	0.20	0.20	0.23	0.20	0.20	0.20
Silver	0.10	0.10	0.10	0.12	0.11	0.10
Zinc	23.6	18.5	27.3	26.4	26.3	21.7

M. nasuta 1999

Parameter	STATION					
	True Control	Reference Control	FH-1	FH-2	FH-3	Archive
Metals (mg/kg)						
Arsenic	1.33	1.76	2.03	1.83	1.56	0.92
Barium	0.42	3.22	2.26	2.38	4.25	0.31
Cadmium	0.10	0.10	0.10	0.11	0.10	0.10
Chromium	0.41	0.37	0.39	0.27	0.23	0.25
Copper	2.91	2.42	2.48	1.89	2.25	2.37
Lead	0.11	0.13	0.10	0.16	0.15	0.10
Nickel	0.97	0.76	0.70	0.53	0.53	0.36
Selenium	0.20	0.20	0.20	0.21	0.20	0.20
Silver	0.10	0.11	0.11	0.10	0.12	0.10
Zinc	13.4	14.2	14.3	14.4	13.3	13.2

TABLE 3.9-9 (Cont'd)

N. virens 2004

Parameter	True Control	Reference Control	FH-EC-01 60+00	FH-EC-02 -45+00	FH-EC-03 -150+00
	STATION				
Metals (mg/kg)					
Arsenic	3.41	2.39	2.39	2.38	2.50
Chromium	0.13	0.08	0.10	0.10	0.10
Copper	1.28	1.23	1.36	1.25	1.30
Lead	0.11	0.11	0.12	0.11	0.13
Nickel	0.32	0.28	0.27	0.24	0.26
Selenium	0.26	0.25	0.25	0.23	0.24
Zinc	12.8	9.13	10.4	13.0	8.90
Bis (2-ethylhexyl) phthalate	67.5	73.0	76.6	85.1	100

M. mercenaria 2004

Parameter	True Control	Reference Control	FH-EC-01 60+00	FH-EC-02 -45+00	FH-EC-03 -150+00
	STATION				
Metals (mg/kg)					
Arsenic	1.99	1.98	1.51	2.03	1.89
Chromium	0.12	0.09	0.09	0.05	0.08
Copper	1.09	0.98	1.00	1.14	1.20
Lead	0.39	0.41	0.32	0.37	0.42
Nickel	0.18	0.20	0.15	0.18	0.15
Selenium	9.19	9.05	8.51	9.27	8.79
Zinc	61.6	65.7	58.7	76.1	74.0
Bis (2-ethylhexyl) phthalate	67.5	73.0	76.6	85.1	100

TABLE 3.9-9 (Concluded)

M. nasuta 2003

Parameter	Control A	Control B	Control C	Reference	Archive
	STATION				
Metals (mg/kg)					
Arsenic	1.83	2.15	2.20	1.77	1.73
Cadmium	0.02	0.03	0.03	0.02	0.03
Chromium	0.17	0.43	0.41	0.20	0.08
Copper	0.90	1.25	1.22	0.95	1.65
Lead	0.11	0.13	0.16	0.18	0.12
Nickel	0.32	0.49	0.64	0.39	0.32
Selenium	0.15	0.12	0.17	nd	0.17
Silver	0.02	0.02	0.03	0.02	0.03
Zinc	6.07	6.95	9.02	6.73	9.60
Low Molecular Wt PAH	0.94	1.34	1.34	0.62	2.84
High Molecular Wt PAH	1.49	1.50	2.41	1.00	6.59
Total PAH	2.43	2.84	3.75	1.62	9.43
Total DDT	0.08	0.12	0.22	0.06	0.09

Parameter	Q1 NW Quadrant	Q2 NE Quadrant	Q3 SE Quadrant	Q4 SW Quadrant	Down Current
	STATION				
Metals (mg/kg)					
Arsenic	1.94	1.87	2.19	2.03	2.13
Cadmium	0.02	0.02	0.02	0.02	0.04
Chromium	0.18	0.25	0.30	0.24	0.23
Copper	1.19	1.22	1.09	1.14	1.24
Lead	0.20	0.20	0.28	0.19	0.22
Nickel	0.30	0.36	0.46	0.38	0.40
Selenium	0.17	0.24	0.14	0.17	0.14
Silver	0.03	0.02	0.03	0.02	0.03
Zinc	6.90	7.10	8.62	7.33	8.41
Low Molecular Wt PAH	2.27	0.99	0.87	0.70	0.72
High Molecular Wt PAH	2.35	1.53	1.57	1.52	1.64
Total PAH	4.62	2.52	2.44	2.22	2.36
Total DDT	0.10	0.11	0.09	0.10	0.11

foreign trade, with roughly 90% of that being imports and 10% being exports. The bulk of the imports are crude petroleum destined for the Phillips Sweeny refinery as well as to refineries in Oklahoma and Nebraska (USACE, 2002). The exports are primarily chemical exports from Dow and BASF. The remaining 20% of the tonnage is domestic. The bulk of this is from barge traffic in the GIWW but some consists of coastwise movements of chemical tankers.

TABLE 3.10-1

DEEP DRAFT TRAFFIC AT PORT FREEPORT, 2003

	Tanker		Pass and Dry Cargo	
Draft (ft)	In	Out	In	Out
42	53		1	
41	16	1	5	
40	14	5	12	
39	38	4	1	
38	50	3		
37	26	12	1	
36	35	8	1	2
35	26	7	2	1
34	16	18	1	1
33	16	15		1
32	35	18		
31	34	25		4
30	32	41	2	15
29	28	32	5	51
28	30	270	65	21
27	25	33	39	29
26	17	40	19	29
25	20	16	8	13
24	28	22	3	4
23	14	16	3	6
22	15	11	3	1
21	5	9	1	
20	19	8	4	2
19	11	2	3	5
18	25	4	75	23
Totals	628	620	254	208
Avg Draft	31.69	28.4	24.57	24.8
Median Draft	31.5	27.7	26.1	26.8

While the majority of the tonnage is crude oil, bulk fuels, and chemicals, there are other commodities moved through the Port. The Port of Freeport has facilities belonging to American Rice Inc. (ARI), Chiquita, and Dole (U.S. Federal Energy Regulatory Commission [FERC], 2004). These are used for rice exports and receipt of bananas, and other commodities.

In terms of vessel movements summarized in Table 3.10-1, the great majority of self propelled cargo vessels are tankers (73%) and the remainder are dry cargo. In terms of numbers, tow traffic is considerably larger with approximately 1,400 towboat movements and 2,300 barges in or out. The great majority of the tow traffic is domestic; it is this that accounts for almost all of the domestic tonnage shown in Table 3.10-2. In addition to the tow traffic that calls on Port Freeport, there is a substantial amount of traffic on the GIWW passing through the Port. Based on the statistics gathered at the Brazos River locks (USACE, 2006), there are over 5,000 tows each direction passing through Port Freeport on the GIWW each year. That averages about 27 tow movements per day through the Port of Freeport.

TABLE 3.10-2

WATERBORNE COMMERCE FOR PORT FREEPORT, 1999–2003

	Total	Domestic	Foreign	Imports	Exports
2003	30,536,657	5,435,996	25,100,661	22,665,591	2,435,070
2002	27,163,872	5,079,632	22,084,240	19,778,106	2,306,134
2001	30,142,822	5,248,758	24,894,064	22,645,478	2,248,586
2000	28,966,389	5,598,981	23,367,408	20,628,455	2,738,953
1999	28,076,004	5,558,866	22,517,138	20,629,944	1,887,194
Average	28,977,149	5,384,447	23,592,702	21,269,515	2,323,187
		Percent of Total		Percent of Foreign	
		19%	81%	90%	10%

Much of the import tonnage is crude oil, with vessels entering loaded and departing with a lower draft. The average and median drafts of the tanker fleet is about 3 ft more for the inbound tankers as the outbound. In contrast, there is little difference in the average or median drafts of the dry cargo vessels.

The USACE Waterborne Commerce system does not record recreational vessel movements in Port Freeport. The number is undoubtedly substantial. The nearby Brazos River Locks tabulates this traffic. In 2001, there were 2,617 recreational vessel trips and 1,245 other noncommercial trips through the East Lock and similar numbers through the West Lock. The EIS for the LNG project (FERC, 2004) compiled data from 2002 provided by TxDOT at the Quintana Island swing bridge (since replaced by a fixed bridge). They reported 700 pleasure boats, 200 shrimp boats, and 200 work boats passing through the area in addition to the tow traffic.

3.10.1 Operating Restrictions

As summarized by the USACE (2002) and FERC (2004) the Port of Freeport imposes the following restrictions on larger vessels:

- Draft: 42 ft to maintain a 3 ft underkeel clearance
- Length: 825 ft LOA, imposed because of crab angle restrictions in the 400-ft-wide channel. This restriction is relaxed in suitable weather—see discussion below.
- Beam: 145 ft. This restriction is relaxed in suitable weather—see discussion below.

- One-way Traffic, imposed due to channel width restrictions
- Daylight Only transits for vessels > 685 ft LOA

These restrictions impose delays on traffic. The length and beam restrictions are relaxed when the wind is less than 20 knots and current across the jetty mouth is negligible (< 0.5 knots). FERC (2004) reports that this condition is not met 25–30% of the time. When those conditions are not met, larger vessels would either have to wait or divert to another port (USACE, 2002).

FERC (2004) reports that the daylight transit and one-way traffic restrictions apply to all vessels over 750 ft long. FERC (2004) also reports that the pilots are currently imposing a moving safety zone around large crude carriers of 2 miles ahead and astern. Port Freeport and pilots have estimated that the worst delays would be 30 to 60 minutes and these would be mitigated by widening of the channel (FERC, 2004). Additionally, an analysis of widening benefits was performed as part of a jetty stability analysis, which is provided in Appendix D.

3.11 VEGETATION

The proposed project is located within Upper Coast division (Hatch et al., 1999) of the Gulf Coast Prairies and Marshes Vegetational Region (Gould, 1975). This Vegetational Region is a nearly level plain less than 250 ft in elevation, covering approximately 10 million acres (Hatch et al., 1990). The Gulf Prairies include the coastal plain that extends approximately 30–80 miles inland. The Gulf Marshes are located in a narrow strip of lowlands that are adjacent to the coast and barrier islands (Hatch et al., 1999).

The project area is limited to the immediate area of the Freeport Harbor Ship Channel and Jetties. The communities of Surfside (to the northeast) and Quintana Beach (to the southwest) are adjacent to the channel. There is very little undeveloped area in the immediate vicinity other than the beach and dunes system. Because of this and because the proposed widening of the ship channel is limited to the existing open water area in the channel vicinity, no wetlands or other plant communities are located in the footprint of the proposed project. According to National Wetland Inventory (NWI) mapping (FWS, 1992a), there is no aquatic vegetation in the open waters of the ship channel and none was observed (other than algae) during field visits for this report. However, there are natural areas (vegetation communities) outside of the footprint of the proposed project that could potentially be impacted by changes in the channel and/or jetties. This includes the beaches and dunes of the Gulf shoreline and interior wetlands that are hydrologically connected to the ship channel via natural and man-made (e.g., GIWW) channels. Another possible impact is from the placement of dredged material. Therefore, baseline data are provided for the Freeport area as shown on Figure 3.11-1.

The vegetation communities, with particular attention to the wetlands have been mapped and described in several studies (McGowen et al., 1976; TPWD, 1999; FWS [NWI], 1992a; White et al., 1988, 2004, 2005; H-GAC, 2002; Bezanson, 2001). However, the Ship Channel is commonly the eastern or western boundary of these studies which focus either on the Galveston Bay System to the northeast or the

Matagorda Bay System to the southwest. So acreage values and trends for plant community types in the Freeport area tend to be swamped by the values and trends in the other estuaries. White et al. (2004 and 2005) do break down the larger areas by subarea including the delta of the diverted channel of the Brazos River and Follet's Island. Some of their findings are presented in this report. In order to provide local data on the vegetation for this report, the general area (approximately 250,000 acres) of the Freeport Ship Channel was defined as the study area (see Figure 3.11-1), and the wetland communities and upland categories were mapped and acreage values calculated.

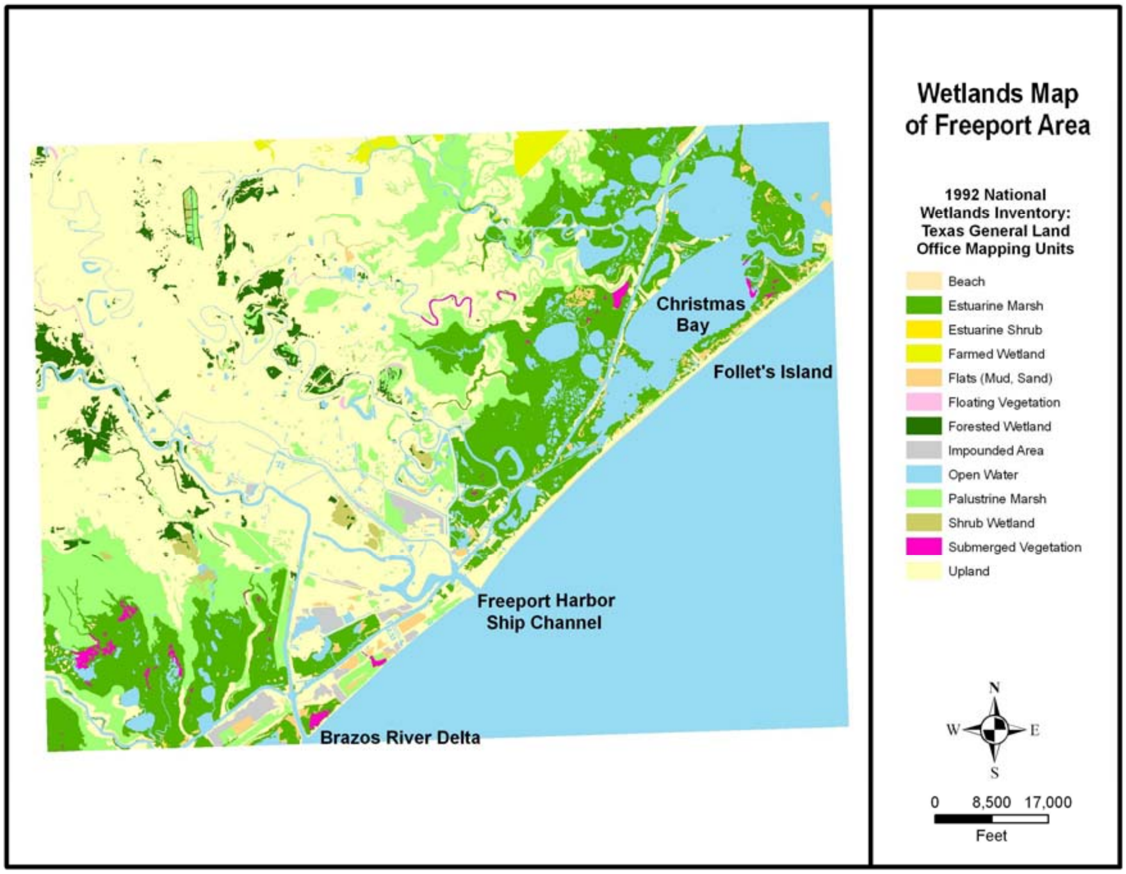

Figure 3.11-1. Freeport Study Area - Wetlands/Uplands (FWS, 1992a)

As can be seen on Figure 3.11-1, the mouth of the Freeport Harbor Ship Channel is in a fairly upland area of the Texas coast line. The wetlands are more extensive to the southwest (Brazos River Delta and the San Bernard National Wildlife Refuge [NWR]) and to the northeast behind the area known as Follet's Island, which includes Christmas Bay and parts of the Brazoria NWR. Figure 3.11-1 uses the Texas GLO mapping categories (e.g., estuarine marsh), which are clumped NWI mapping units (based on the Cowardin et al. [1979] classification system). The acreage values listed later in this report for each of the community types are based on the NWI categories, and are basically the same as the GLO categories, except that the flats and aquatic vegetation are differentiated into estuarine and freshwater.

Uplands in the City of Freeport area include developed areas as well as dunes and relic beach ridges that support grassland vegetation. The interior uplands include grasslands and pastures and woodlands, including bottomland hardwood forests.

An important ecosystem that occurs in this area is the Columbia Bottomlands, which is located in the floodplains of the Brazos, San Bernard and Colorado Rivers (Figure 3.11-2). The ecological importance of this area is described in the Strategic Conservation Plan for the Columbia Bottomlands (The Nature Conservancy [TNC], 2004), which was produced by the FWS, National Fish and Wildlife Foundation, Trust for Public Land, TPWD, Gulf Coast Bird Observatory, and TNC. The plant communities in the Columbia Bottomlands area include marshes, forested wetlands, small scattered prairies, and bottomland hardwood forests (TNC, 2004). According to the conservation plan (TNC, 2004), the majority of the forests and woodlands are one of three communities including Live Oak (*Quercus virginiana*) Forest, Coastal Live Oak – Pecan (*Q. virginiana* – *Carya illinoinensis*), and Columbia Bottomlands Ash (*Fraxinus pennsylvanica*) Flats. The Live Oak Forest species include Texas yaupon (*Ilex vomitoria*), dwarf palmetto (*Sabal minor*), Cherokee sedge (*Carex cherokeensis*), and Drummond's wax-mallow (*Malvaviscus arboreus* var. *drummondii*). Columbia Bottomlands Ash Flats species include water hickory (*Carya aquatica*), eastern swamp privet (*Forestiera acuminata*), and swamp panic grass (*Panicum gymnocarpon*). White et al. (1988) described some of this area as "abundant fluvial woodlands that that have been cleared along straight lines to produce rangeland and cropland."

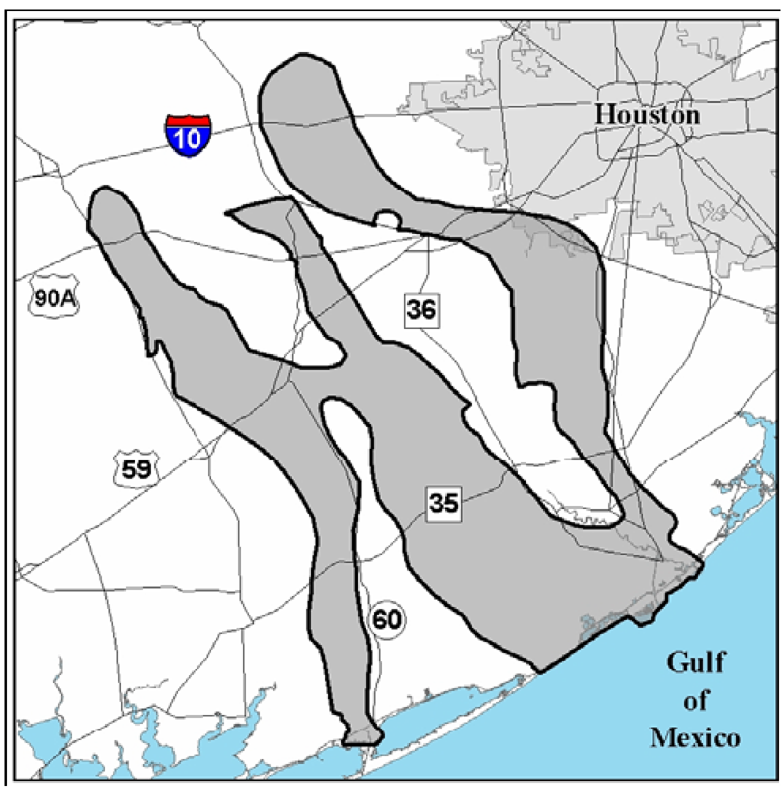

Figure 3.11-2. Columbia Bottomlands Conservation Area *(from TNC, 2004)*

Diamond and Smeins (1987) describe additional forest and woodlands that occur in the Upper Coastal Prairie including Coastal Live Oak/Post Oak (*Quercus stellata*) Forest, Water oak (*Quercus nigra*)/ Coastal Live Oaks Forest, and Mesquite-Huisache (*Prosopis glandulosa-Acacia farnesiana*) Shrublands.

The upland grasslands within the study area include:

- pasture lands, dominated by introduced species including bermudagrass (*Cynodon dactylon*) and bahaigrass (*Paspalum notatum*);

- remnants of the original coastal prairie, with common species including little bluestem (*Schizachyrium scoparium*), brownseed paspalum (*Paspalum plicatulum*), indiangrass (*Sorghastrum nutans*), rosettegrass (*Panicum oligosanthes*), and thin paspalum (*Paspalum setaceum*); and

- beach and dune communities. Typical plant species of the primary dunes include sea oats (*Uniola paniculata*), bitter panicum (*Panicum amarum*), Gulf croton (*Croton punctatus*), beach morning glory (*Ipomea pes-caprae*), and fiddleleaf morning glory (*Ipomea stolonifera*). Secondary dune species include marshhay cordgrass (*Spartina patens*), seashore dropseed (*Sporobolus virginicus*), seacoast bluestem (*Schizachyrium littorale*), seashore saltgrass, pennywort (*Hydrocotyle bonariensis*), and partridge pea (*Chamaecrista fasciculata*). The secondary dune community, which is located in the hummocky area leeward of the higher and drier primary dunes, is often a wetland community or considered a transitional community between upland and wetland.

Beaches along the south Texas coastline are dynamic habitats subject to a variety of environmental influences such as wind and wave action, salt spray, high temperature, and moisture stress. White et al. (2005) reports that erosion rates locally exceed 39 ft/year. The harsh conditions associated with the beach/ dune system support a relatively small number of adapted animals and plants. Sand dunes help absorb the impacts of storm surges and high waves and also serve to slow the intrusion of water inland. In addition, dunes store sand that helps deter shoreline erosion and replenish eroded beaches after storms. The dune complexes are of two types, primary and secondary, each of which supports a unique plant community. The primary dunes are taller and offer more protection from wind and hurricane storm surge. The coastal shore areas serve as buffers protecting upland habitats from erosion and storm damage, and adjacent marshes and waterways from water-quality problems.

3.12 WETLANDS

Unlike most of the major river systems in Texas, there is no bay associated with the Freeport area (McGowen et al. [1976] present a detailed on the history of the geological development of the area which caused this condition). Also, there is no active delta or direct inflow from the river into the Port of Freeport Ship Channel area because the river was diverted approximately 7 miles to the southwest in 1929. These two factors, in addition to construction associated with the GIWW, the ship channel, and the towns of Surfside and Quintana, explain why there are no wetlands in the immediate area of the historic mouth of the Brazos River.

Coastal wetlands (saline to freshwater) are distinct areas between terrestrial and aquatic systems where the water table is at or near the surface or the land is covered by shallow water with emergent vegetation. They are important natural resources that provide essential habitat for fish, shellfish, and other wildlife. Coastal wetlands also serve to filter and process agricultural and urban runoff and buffer coastal areas against storm and wave damage.

The condition and distribution of wetland types can be affected by changes in depth and frequency of inundation as well as salinity. White et al. (2005) reports that relative sea-level rise in the Freeport area exceeded 0.43 inch/year from 1959 through 1971. They stress that these are short-term rates which can be affected by variations caused by climatic factors (e.g., droughts and high rainfall periods). The overall relative sea level is also affected by subsidence, which may be as high as 5 ft in the Freeport area according to their report.

Descriptions of the wetland plant communities (including aquatic vegetation) that occur in the study area appear in the following paragraphs.

3.12.1 Estuarine Submerged Aquatic Vegetation

Seagrasses, which are submerged aquatic vegetation (SAV), are considered to be critical coastal nursery habitat for estuarine fisheries and wildlife. They also serve as a food source for fish, waterfowl, and turtles. They contribute organic matter to the nutrient cycle and stabilize coastal sedimentation and erosion processes (TPWD, 1999).

The 1992 FWS NWI data map saline-brackish (estuarine) and freshwater (palustrine and lacustrine) aquatic vegetation in the study area. There is no aquatic vegetation mapped (FWS, 1992b) within 1 mile of the proposed project. There are 630 acres of estuarine SAV within the study area. The estuarine SAV species probably include true seagrasses, primarily shoalgrass (*Halodule wrightii*), and widgeongrass (*Ruppia maritima*). The 1992 FWS NWI map of SAV does not show a significant amount of estuarine SAV (approximately 70 acres) in Christmas Bay (on western edge of the Galveston Bay estuary). White et al. (2004) report approximately 170 acres of SAV in the Follet's Island area (including Christmas Bay) in 2001. Both the 1992 (FWS) and 2001 (White et al., 2004) maps show estuarine SAV in the inter-ridge swales of the Brazos River delta. These deltaic SAV and estuarine marshes are separated by a leveed DMPA from lacustrine (freshwater) SAV and marsh to the northeast.

3.12.2 Estuarine Marshes – Salt/Brackish

The low estuarine marshes (i.e., frequently inundated) are generally at lower elevations than the high marshes. The dominant species in the low salt marshes are smooth cordgrass (*Spartina alterniflora*) and secondarily, seashore saltgrass (*Distichlis spicata*). These are often interspersed with low brackish marshes, dominated by saltmarsh bulrush (*Bolboschoenus robustus*) and glasswort (*Salicornia virginicus*). Commonly, the low salt marsh is adjacent to open water areas with the low brackish marsh adjacent to the low salt marsh. At slightly higher elevations (and less frequently inundated) are the high salt/brackish marshes. Common species in the high marshes include sea ox-eye daisy (*Borrichia frutescens*), saltwort (*Batis maritima*), and shoregrass (*Monanthochloe littoralis*).

White et al. (1988) described some of these communities in the active Brazos River delta, where they occur in the swales between upland ridges (relic beach ridges). Smooth cordgrass is abundant in the proximal saltwater marshes and intergrades with saltgrass at higher elevations. There are brackish marshes in the delta which support cattails (*Typha* sp.), saltmarsh bulrush, American bulrush (*Schoenoplectus pungens* var. *longispicatus*), jointed flatsedge (*Cyperus articulatus*), black rush (*Juncus roemerianus*), and saltgrass. They also report extensive stands of black rush and cattails in the swales near Quintana. White et al. (2004) found that the most significant trend in the Brazos Delta and surrounding area was the 30% overall loss of estuarine marsh from the 1950s to 2002. Some of this loss was due to the erosion of marshes that had developed at the mouth of the diverted Brazos River. Some of that was offset by delta progradation (and marsh creation) on the southwestern side (down drift) of the mouth of the river. There was also marsh loss along the GIWW due to the placement of dredged material, which converted marshes to uplands. They estimate that 50% of the marsh loss in the Brazos delta area was the result of conversion to upland habitat.

There are approximately 31,400 acres of estuarine wetlands (not including flats) in the study area. Most of this (approximately 70%) is mapped as high marsh.

3.12.3 Estuarine Shrub-Scrub Wetlands – Salt/Brackish

The estuarine intertidal scrub-shrub category describes coastal wetlands dominated by woody vegetation and periodically flooded by tidal waters. Examples of estuarine intertidal scrub-shrub species in the study area include big leaf sumpweed (*Iva frutescens*), the exotic invasive tamarisk (*Tamarix* spp.), and bushy sea-ox-eye (*Borrichia frutescens*). There are approximately 38 acres of estuarine shrubland in the study area.

3.12.4 Estuarine Tidal Flats

This community type includes coastal wetlands periodically flooded by tidal waters and with less than 30% areal coverage by vegetation. This category includes sandbars, mud flats, and other nonvegetated or sparsely vegetated habitats called salt flats. Sparse vegetation of salt flats may include glasswort, saltwort, and shoregrass. These tidal flats serve as valuable feeding grounds for coastal shorebirds, including the threatened piping plover; fish; and invertebrates. There are approximately 1,530 acres of this category within the study area.

3.12.5 Freshwater Aquatic Vegetation – Submerged and Floating

The NWI map which maps farther inland than the White et al. Status and Trends studies (2004, 2005) shows approximately 250 acres of freshwater floating vegetation within the study area, generally located in ditches and abandoned channels. Species may include the invasive exotic species, water hyacinth (*Eichornia crassipes*), water lettuce (*Pistia stratiotes*) or frogbit (*Linobium spongia*). There are also approximately 280 acres of fresh SAV. Species may include widgeongrass, as well as other strictly fresh-intermediate species like Sago pondweed (*Potamogeton pectinatus*), cabomba (*Cabomba caroliniana*), and mermaid weed (*Proserpinica palustris*).

3.12.6 Freshwater Marshes

The estuarine system extends landward to the point where ocean-derived salts are less than 0.5 ppt (during average annual low flow) (Cowardin et al., 1979). Freshwater marshes include those categories mapped by NWI as palustrine, riverine and lacustrine. Common species include spikerush (*Eleocharis* sp.), flat-sedge (*Cyperus* spp.), rushes (*Juncus* spp.), smartweed (*Polygonum* sp.), coastal water-hyssop (*Bacopa monnieri*), seashore paspalum (*Paspalum vaginatum*), California bulrush (*Schoenoplectus californicus*), coastal cattails (*Typha domingensis*), jointed flatsedge, and American bulrush (*Schoenoplectus pungens*).

Most of the freshwater marshes are located at more inland locations, but some occur in swales near the Gulf shoreline, as noted in the previous section on estuarine marshes. There are approximately 24,000 acres of freshwater marsh (including wet meadows which are at the drier end of the spectrum) in the study area. This number does not include the agricultural wetlands (rice farms) that cover approximately 1,150 acres.

3.12.7 Freshwater Shrub-Scrub Wetlands

Freshwater shrub-scrub wetlands in the coastal zone may include the woody species such as buttonbush (*Cephalanthus occidentalis*), baccharis shrub (*Baccharis* sp.), big leaf sumpweed, and tamarisk. There are approximately 1,218 acres of freshwater shrub-scrub wetland in the study area.

3.12.8 Freshwater Forested Wetlands

The forested wetlands are located more inland, upstream along the river, creeks, and sloughs of the Columbia Bottomland, as described earlier. These wetlands are primarily associated with active and abandoned channels. This pattern can be seen in Figure 3.11-1. There are approximately 4,697 acres of forested wetlands in the study area. The plant communities include the Columbia Bottomlands Ash Flats (dominated by green ash and include water hickory, eastern swamp privet, and swamp panic grass) and Water Oak Flats. Bald cypress (*Taxodium distichum*) also occurs along some of the waterways.

3.12.9 Freshwater Flats

Freshwater flats are unvegetated to sparsely vegetated areas with sand or mud substrate. Common species are the same as freshwater marshes. There are approximately 244 acres of freshwater flats in the study area.

3.13 TERRESTRIAL WILDLIFE

The study area is within the Texan Biotic Province, as described by Blair (1950). The climate of the region is moist subhumid, with some excess rainfall. The vertebrate fauna of the province includes considerable elements of Austroriparian as well as grassland species. Wildlife habitats within the study area include beach, shell ramp-barrier flats, dredged material, salt-water marsh, brackish- to fresh-water marsh, fresh- to brackish-water bodies (i.e., ponds and lakes), grassland, and fluvial woodland (McGowen et al., 1976).

The Texan Biotic Province supports a diverse fauna composed of a mixture of species common to neighboring provinces. Austroriparian species from the east are generally restricted to forests, bogs, and marshes. Grassland species, entering the area from the west, are generally restricted to the prairies (Blair, 1950). No vertebrate species are endemic to the Texan Biotic Province (Blair, 1950).

At least 49 mammal species occur or have occurred in the Texan Biotic Province (Blair, 1950). Although terrestrial habitat is of limited extent in the study area, common terrestrial mammals of potential occurrence include Virginia opossum (*Didelphis virginiana*), swamp rabbit (*Sylvilagus aquaticus*), black-tailed jackrabbit (*Lepus californicus*), marsh rice rat (*Oryzomys palustris*), fulvous harvest mouse (*Reithrodontomys fulvescens*), hispid cotton rat (*Sigmodon hispidus*), nutria (*Myocastor coypus*), coyote (*Canis latrans*), northern raccoon (*Procyon lotor*), and striped skunk (*Mephitis mephitis*) (Schmidly, 2004). Marine mammals of potential occurrence in the study area include the bottlenose dolphin (*Tursiops truncatus*).

At least 16 species of lizards and 39 species of snakes occur or have occurred in the Texan Biotic Province (Blair, 1950). In addition, at least five urodeles (newts and salamanders) and 18 anurans (frogs and toads) have occurred in the Texan Biotic Province (Blair, 1950). Terrestrial amphibian and reptile species of potential occurrence in the study area include Blanchard's cricket frog (*Acris crepitans blanchardi*), Gulf Coast toad (*Bufo nebulifer*), green treefrog (*Hyla cinerea*), squirrel treefrog (*Hyla squirella*), American bullfrog (*Rana catesbeiana*), green anole (*Anolis carolinensis*), eastern six-lined racerunner (*Aspidoscelis sexlineata sexlineata*), Mediterranean house gecko (*Hemidactylus turcicus*), western cottonmouth (*Agkistrodon piscivorus leucostoma*), western diamond-backed rattlesnake (*Crotalus atrox*), several species of watersnake (*Nerodia* spp.), Gulf saltmarsh snake (*Nerodia clarkii clarkii*), and Gulf Coast ribbonsnake (*Thamnophis proximus orarius*) (Dixon, 2000). Aquatic reptile species of potential occurrence in the study area include American alligator (*Alligator mississippiensis*) and Texas diamond-backed terrapin (*Malaclemys terrapin littoralis*) (Dixon, 2000).

The study area supports an abundant and diverse avifauna. Tidal flats, bay margins, and beaches provide excellent habitat for numerous species of herons and egrets, shorebirds, wading birds, gulls, and terns. According to the FWS Texas Colonial Waterbird Census (TCWC) (FWS, 2005), several rookeries occur within the study area (Figure 3.13-1). Table 3.13-1 provides information on nesting activities at these rookeries. Common species of potential occurrence in the study area include great blue heron (*Ardea herodias*), great egret (*Ardea alba*), snowy egret (*Egretta thula*), little blue heron (*Egretta caerulea*), white ibis (*Eudocimus albus*), roseate spoonbill (*Platalea ajaja*), clapper rail (*Rallus longirostris*), common moorhen (*Gallinula chloropus*), killdeer (*Charadrius vociferus*), black-necked stilt (*Himantopus mexicanus*), yellowlegs (*Tringa* spp.), willet (*Catoptrophorus semipalmatus*), long-billed curlew (*Numenius americanus*), sanderling (*Calidris alba*), least sandpiper (*Calidris minutilla*), dunlin (*Calidris alpina*), dowitchers (*Limnodromus* spp.), Wilson's snipe (*Gallinago delicata*), laughing gull (*Larus atricilla*), ring-billed gull (*Larus delawarensis*), herring gull (*Larus argentatus*), Forster's tern (*Sterna forsteri*), and least tern (*Sterna antillarum*) (FWS, n.d.; Richardson et al., 1998). In addition, prairies and marshes provide habitat for numerous waterfowl, several species of raptors, and a variety of songbirds. Texas is one of the most significant waterfowl wintering regions in North America with three to five million waterfowl annually wintering in the State (Texas Coastal Management Program [TCMP], 1996). In addition, the mainland and barrier islands of the Texas Gulf coast provide critical stopover habitat for numerous species of neotropical songbirds during migration.

3.14 AQUATIC ECOLOGY

3.14.1 Aquatic Communities

The study area includes a small portion of the old Brazos River Channel and the Gulf nearshore waters at the Freeport Harbor Channel. Within the study area, environmental fluctuations are extreme and the inhabitant biota reflect and are adapted to this lack of stability in the environment (Warshaw, 1975). Large changes in habitat can occur on a daily basis with respect to wind, tidal action, salinity regimes, and freshwater inflow. These ongoing natural processes are coupled with other natural events such as freezes, droughts, hurricanes, and anthropogenic pressures (i.e., management practices and coastal projects) in the study area. Nevertheless, the biological community present in the study area remains diverse and abundant. The Gulf nearshore community includes many species found in both estuarine and offshore oceanic habitats (Tunnell et al., 1996). Most of the species in the Gulf nearshore waters are temperate in biogeographic distribution with a few tropical species (Tunnell et al., 1996).

Many aquatic communities are present in the study area that serve to support the ecological diversity and abundance. These include commercial and recreational species, oyster reef habitat, offshore sands, and artificial reefs. Commercial and recreational species are discussed in detail below. Other fish species found mainly in shallow areas include Gulf killifish (*Fundulus grandis*), sheepshead minnow (*Cyprinodon variegates*), and silversides (*Menidia* sp.) (Pattillo et al., 1997). Inhabitants of marsh areas include the pinfish (*Lagodon rhomboids*), silver perch (*Bairdiella chrysoura*), and gizzard shad (*Dorosoma cepedianum*) (Pattillo et al., 1997). Species often found in deeper areas include the Atlantic

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Figure 3.13-1

Project Area Rookeries

Prepared for: Erik Huebner	
Job No.: 441591.00	Scale: 1:75,000
Prepared by: RF Cooper	Date: July 18, 2006
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TABLE 3.13-1

NUMBER OF NESTS OF COLONIAL WATERBIRDS
AT SELECTED ROOKERIES IN THE STUDY AREA

Rookery/ID	Common Name	Scientific Name	2000	2001	2002	2003	2004	2005
Freeport Dow/ 610-100	Black skimmer	*Rynchops niger*	500	725	1,600		380	320
	Gull-billed tern	*Sterna nilotica*	60	72	60		25	
	Least tern	*Sterna antillarum*	17	50	40		30	40
Bryan Beach SP/ 610-101	Black skimmer	*Rynchops niger*						
	Least tern	*Sterna antillarum*						
Bryan Beach Spoil/610-102	Tricolored heron	*Egretta tricolor*						
	Little blue heron	*Egretta caerulea*						
	Least tern	*Sterna antillarum*						
	Great egret	*Ardea alba*						
	Great blue heron	*Ardea herodias*						
	Cattle egret	*Bubulcus ibis*						
	Black skimmer	*Rynchops niger*						
Bryan Mound/ 610-103	Roseate spoonbill	*Ajaia ajaja*	30	8				
	Neotropic cormorant	*Phalacrocorax brasilianus*	60	20				
	Least tern	*Sterna antillarum*	15	5				
	Gull-billed tern	*Sterna nilotica*						
	Great egret	*Ardea alba*	5	4				
	Great blue heron	*Ardea herodias*	4	3				
	Cattle egret	*Bubulcus ibis*	200					
	White ibis	*Eudocimus albus*						
	White-faced ibis	*Plegadis chihi*						
	Tricolored heron	*Egretta tricolor*						
	Snowy egret	*Egretta thula*		1				
	Black-crowned night-heron	*Nycticorax nycticorax*	2					
Dow Gate A-40/ 610-104	Least tern	*Sterna antillarum*	2	6				
Dow Tern/610-105	Least tern	*Sterna antillarum*						
Bryan Beach Diked Spoil/610-106	N/A							

Source: TCWC Database (FWS, 2006b)

croaker (*Micropogonias undulatus*), Gulf menhaden (*Brevoortia patronus*), and hardhead catfish (*Arius felis*), while a number of fish occur in abundance in both marsh and deeper areas, including bay anchovy (*Anchoa mitchilli*), spot (*Leiostomus xanthurus*), and striped mullet (*Mugil cephalus*) (Pattillo et al., 1997). These species are ubiquitous along the Texas coast and are unaffected by changes in salinity. Seasonal differences occur in abundance with the fall usually being the smallest in biomass and number. Newly spawned fish and shellfish begin migrating into the estuary in winter and early spring with the maximum biomass observed during the summer months (Parker, 1965). A list of fish species found in the study area is presented in Table 3.14-1.

The entire food chain is dependent on the microscopic plankton which utilize nutrients and provide an abundant food source. The plankton community consists of small plants (phytoplankton) and animals (zooplankton) that are suspended in the water column. Diverse and abundant plankton communities exist throughout the study area. The dominant phytoplankton assemblages include diatoms, green algae, and blue-green algae, while the dominant zooplankton include the barnacle nauplii, the copepod *Acartia tonsa*, and the dinoflagellate *Noctiluca scintillans* (Armstrong et al., 1987).

The open-water/open-bay bottom includes all areas of the study area not covered with oyster reefs (Lester and Gonzales, 2001). Benthic organisms are divided into two groups: epifauna, such as crabs and smaller crustaceans, which live on the surface of the bottom substrate, and infauna, such as mollusks and polychaetes, which burrow into the bottom substrate (Green et al., 1992). Mollusks and some other infaunal organisms are filter feeders which strain suspended particles from the water column. Others, such as polychaetes, feed by ingesting sediments and extracting nutrients. Many of the epifauna and infauna feed on plankton, and are then fed upon by numerous fish and birds (Armstrong et al., 1987; Lester and Gonzales, 2001). The open-water/open-bay bottom includes flat areas consisting of mud and sand that contribute large quantities of nutrients and food, making them one of the most important components of this habitat type. The distribution of the benthic macroinvertebrates is primarily influenced by bathymetry and sediment type (Calnan et al., 1988). Benthic macroinvertebrates found in the sediments of the Bay City-Freeport area are primarily polychaetes, bivalves, gastropods, and crustaceans (Calnan et al., 1988). The dominant bivalves include the dwarf surf clam (*Mulinia lateralis*) and the concentric nut clam (*Nuculana concentrica*); the dominant gastropods are the Eastern white slipper shell (*Crepidula plana*) and the vitrinella (*Vitrinella floridana*); the dominant polychaetes are *Mediomastus californiensis* and *Paraprionospio pinnata*; and the dominant crustaceans are *Ampelisca abdita* and *Ampelisca agassizi*.

3.14.1.1 Recreational and Commercial Species

Over the years many commercially important fish have been subject to overfishing and subsequent decline in the Gulf of Mexico. In recent years, however, certain fish stocks in the Gulf of Mexico are no longer overfished and are beginning to show signs of rebuilding (NOAA, 2004). TPWD does not collect commercial or recreational fishery statistics for the Brazos River estuary. The most important commercially harvestable species that utilize the Brazos River estuary include brown shrimp (*Farfantepenaeus aztecus*), white shrimp (*Litopenaeus setiferus*), pink shrimp (*Farfantepenaeus

TABLE 3.14-1
FISH SPECIES FOUND WITHIN THE STUDY AREA

Common Name	Scientific Name	Relative Abundance
Bay squid	*Lolliguncula brevis*	common
Brown shrimp	*Farfantepenaeus aztecus*	abundant
Pink shrimp	*Penaeus duorarum*	common
White shrimp	*Litopenaeus setiferus*	abundant
Grass shrimp	*Palaemonetes pugio*	highly abundant
Blue crab	*Callinectes sapidus*	common
Gulf menhaden	*Brevoortia patronus*	abundant
Gizzard shad	*Dorosoma cepedianum*	common
Bay anchovy	*Anchoa mitchilli*	highly abundant
Hardhead catfish	*Arius felis*	common
Sheepshead minnow	*Cyprinodon variegatus*	abundant
Gulf killifish	*Fundulus grandis*	abundant
Silversides	*Menidia* sp.	abundant
Bluefish	*Pomatomus saltatrix*	common
Crevalle jack	*Caranx hippos*	common
Gray snapper	*Lutjanus griseus*	common
Pinfish	*Lagodon rhomboides*	abundant
Silver perch	*Bairdiella chrysoura*	common
Sand trout	*Cynoscion arenarius*	common
Spotted trout	*Cynoscion nebulosus*	common
Spot	*Leiostomus xanthurus*	abundant
Atlantic croaker	*Micropogonias undulatus*	highly abundant
Black drum	*Pogonias cromis*	common
Red drum	*Sciaenops ocellatus*	common
Striped mullet	*Mugil cephalus*	common
Spanish mackerel	*Scomberomorous maculatus*	rare
Southern flounder	*Paralichthys lethostigma*	common
Gag grouper	*Mycteroperca microlepis*	occurrence
Scamp	*Mycteroperca phenax*	occurrence
Red snapper	*Lutjanus campechanus*	common
Lane snapper	*Lutjanus synagris*	common
Greater amberjack	*Seriola dumerilli*	common
King mackerel	*Scomberomorus cavalla*	common
Cobia	*Rachycentron canadum*	common

Source: Pattilo et al., 1997, GMFMC, 1998 *duorarum*), blue crab (*Callinectes sapidus*), and southern flounder (*Paralichthys lethostigma*). Important recreational species include red drum (*Sciaenops ocellatus*), red snapper (*Lutjanus campechanus*), speckled trout (*Cynoscion nebulosus*), black drum (*Pogonias cromis*), southern flounder, greater amberjack (*Seriola dumerili*), Spanish mackerel (*Scomberomorus maculatus*), and king mackerel (*Scomberomorus cavalla*). No oysters are commercially harvested within the study area.

3.14.1.2 Oyster Reef Habitat

Many organisms, including mollusks, polychaetes, barnacles, crabs, gastropods, amphipods, polychaetes, and isopods can be found living on oyster reefs, forming a very diverse community (Sheridan et al., 1989). Oyster reef communities are dependent upon food resources from the open bay and marshes. Many organisms feed on oysters including fish, such as black drum, crabs (*Callinectes* spp.), and gastropods such as the oyster drill (*Thais haemastoma*) (Sheridan et al., 1989; Lester and Gonzales, 2001). When oyster reefs are exposed during low tides, shore birds will use the reef areas as resting places (Armstrong et al., 1987).

Scattered reefs of Eastern oyster (*Crassostrea virginica*) are present in areas surrounding Oyster Creek and scattered oyster are found in many of the nearby open-water areas (Swan Lake, Bryan Lake); however, no oysters are found within the immediate project area. Oysters are not commercially harvested from the Brazos River estuary. The Freeport area has been classified as restricted by the Texas Department of Health (TDH) and is closed to the harvesting of molluscan shellfish from this system (TDH, 2006). In addition, TDH does not have any bay water sampling stations for monitoring oysters within the Brazos River estuary (Heideman, 2006).

3.14.1.3 Offshore Sands

There are few seagrasses or attached algae found in the offshore sands due to the strong currents and unstable sediments. Most of the bottom surface is populated with macroinfauna, with the exception of an occasional hermit crab, portunid crab, or ray. Even though there is little life on the sand surface itself, the overlying waters are highly productive. Phytoplankton are abundant, including microscopic diatoms, dinoflagellates, and other algae (Britton and Morton, 1989).

Much of the faunal diversity lies buried in the sand and relies on the phytoplankton for food. Bivalves found in offshore sands include the blood ark (*Anadara ovalis*), incongruous ark (*Anadara brasiliana*), southern quahog (*Mercenaria campechiensis*), giant cockle (*Dinocardium robustum*), disk dosinia (*Dosinia discus*), pen shells (*Atrina serrata*), common egg cockle (*Laevicardium laevigatum*), cross-barred venus (*Chione cancellata*), tellins (*Tellina* spp.), and the tusk shell (*Dentalium texasianum*). One of the most common species occurring in the shallow offshore sands is the sand dollar (*Mellita quinquiesperforata*) as well as several species of brittle stars (*Hemipholis elongata*, *Ophiolepis elegans*, and *Ophiothrix angulata*). Many gastropods are common, including the moon snail (*Polinices duplicatus*), ear snail (*Sinum perspectivum*), Texas olive (*Oliva sayana*), Atlantic auger (*Terebra dislocata*), Salle's ager (*Terebra salleano*), scotch bonnet (*Phalium granulatum*), distroted triton

(*Distrosio clathrata*), wentletraps (*Epitonium* sp.), and whelks (*Busycon* spp.). Crustaceans inhabiting these waters include white and brown shrimp (both commercially caught species), rock shrimp (*Sicyonia brevirostris*), blue crabs, mole crabs (*Albunea* spp.), speckled crab (*Arenaeus cribrarius*), box crab (*Calappa sulcata*), calico crab (*Hepatus epheliticus*), and pea crab (*Pinotheres maculatus*). The most abundant infaunal organism, with respect to the number of individuals, are the polychaetes (Capitellidae, Orbiniidae, Magelonidae, and Paraonidae) (Britton and Morton, 1989).

3.14.1.4 Artificial Reefs

In the Gulf, two types of artificial reefs exist, those structures placed to serve as oil and gas production platforms and those intentionally placed to serve as artificial reefs (Gulf of Mexico Fisheries Management Council [GMFMC], 2004). The more than 4,500 oil and gas structures in the Gulf form unique reef ecosystems that extend throughout the water column providing a large volume and surface area, dynamic water flow characteristics, and a strong profile (Ditton and Falk, 1981; Dokken, 1997; Stanley and Wilson, 1990; Vitale and Dokken, 2000). Fish are attracted to oil platforms because these structures provide food, shelter from predators and ocean currents, and a visual reference which aids in navigation for migrating fishes (Bohnsack, 1989; Duedall and Champ, 1991; Meier, 1989; Vitale and Dokken, 2000). The size and shape of the structure affect community characteristics of pelagic, demersal, and benthic fishes (Stanley and Wilson, 1990). Many scientists feel that the presence of oil platform structures allows fish populations to grow, which increases fishery potential (Scarborough-Bull and Kendall, 1992).

Artificial reefs are colonized by a diverse array of microorganisms, algae, and sessile invertebrates including shelled forms (barnacles, oysters, and mussels), as well as soft corals (bryozoans, hydroids, sponges, and octocorals) and hard corals (encrusting, colonial forms). These organisms (referred to as the biofouling community) provide habitat and food for many motile invertebrates and fishes (GMFMC, 2004).

Species associated with the platforms that are not dependent on the biofouling community for food or cover include the Atlantic spadefish (*Chaetodipterus faber*), lookdown (*Selene vomer*), Atlantic moonfish (*Selene setapinnis*), creole-fish (*Paranthias furcifer*), whitespotted soapfish (*Rypticus maculatus*), gray triggerfish (*Balistes capriscus*), and lane snapper (*Lutjanus synagris*), all transients (move from platform to platform), and resident species (always found on the platforms) including red snapper, large tomate (*Haemulon aurolineatum*), and some large groupers. Other resident species that are dependent upon the biofouling community for food or cover include numerous species of blennies, sheepshead, and small grazers (butterflyfishes, Chaetodontidae). Highly transient, large predators associated with these structures include barracuda (*Sphyraena barracuda*), almaco jack (*Seriola rivoliana*), hammerhead sharks (*Sphyrna* spp.), cobia (*Rachycentron canadum*), mackerels (Scombridae), other jacks (*Caranx* sp.), and the little tunny (*Euthynnus alletteratus*) (GMFMC, 2004).

There appear to be no platforms within 5 miles of the end of the jetties and only 9 within 10 miles of the end of jetties (NOAA Coast Survey Nautical Chart 11321, 30th Ed., July 2004). The *George Vancouver*, a

Liberty Ship, which is part of the TPWD artificial reef program, is located about 10½ miles southwest of Freeport.

3.14.2 Essential Fish Habitat

Congress enacted amendments to the Magnuson-Stevens Fishery Conservation and Management Act (PL 94-265) in 1996 that established procedures for identifying Essential Fish Habitat (EFH) and required interagency coordination to further the conservation of Federally managed fisheries. Rules published by the NMFS (50 CFR Sections 600.805–600.930) specify that any Federal agency that authorizes, funds or undertakes, or proposes to authorize, fund, or undertake an activity which could adversely affect EFH is subject to the consultation provisions of the above mentioned act and identifies consultation requirements. A letter (Appendix E) was submitted to NMFS requesting a list of EFHs in the study area.

EFH is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." When referring to estuaries, it is further defined as "all waters and substrates (mud, sand, shell, rock and associated biological communities) within these estuarine boundaries, including the sub-tidal vegetation (seagrasses and algae) and adjacent tidal vegetation (marshes and mangroves)" (GMFMC, 2004).

The GMFMC has identified the study area as EFH for adult and juvenile brown, white, and pink shrimp, red drum, gag grouper (*Mycteroperca microlepis*), scamp (*Mycteroperca phenax*), red snapper, gray snapper (*Lutjanus griseus*), lane snapper (*Lutjanus synagris*), greater amberjack, king mackerel, Spanish mackerel, and cobia (*Rachycentron canadum*).

The following describes the preferred habitat, life history stages, and relative abundance of each EFH managed species based on information provided by GMFMC (2004). Table 3.14-2 describes EFH for each of these species.

Brown Shrimp: Brown shrimp eggs are demersal and are deposited offshore. The larvae begin to migrate through passes with flood tides into estuaries as postlarvae. Migrating occurs at night mainly from February to April, with a minor peak in the fall. Brown shrimp postlarvae and juveniles are associated with shallow vegetated habitats in estuaries, but are also found over silty sand and nonvegetated mud bottoms. Postlarvae and juveniles occur in salinity ranging from zero to 70 ppt. The density of late postlarvae and juvenile brown shrimp are highest in marsh edge habitat and submerged vegetation, followed by tidal creeks, inner marsh, shallow, open water and oyster reefs. Muddy substrates seem to be preferred in unvegetated areas. Juvenile and subadult brown shrimp can be found from secondary estuarine channels out to the continental shelf, but prefer shallow estuarine habitats, such as soft, muddy areas associated with plant-water interfaces. Subadult brown shrimp migrate from estuaries, at night, on ebb tides during new and full moon phases in the Gulf. Their abundance offshore correlates positively with turbidity and negatively with hypoxia (low levels of oxygen in the water). Adult brown shrimp inhabit neritic Gulf waters (marine waters extending from MLT to the edge of the continental shelf) and

TABLE 3.14-2
ESSENTIAL FISH HABITAT - ADULT AND JUVENILE PRESENCE
IN THE PORT OF FREEPORT STUDY AREA

	ESTUARINE		MARINE	
Common Name/Scientific Name	Adults	Juvenile	Adults	Juvenile
Brown shrimp (*Penaeus aztecus*)	*not present*	*abundant* year-round	major adult area spring, summer, fall spawn year-round at depths greater than 13 m	spawning area
White shrimp (*Penaeus setiferus*)	*common* April-June	*abundant* November-June *highly abundant* July-October	adult area year-round	not present in study area
Pink shrimp (*Penaeus duroarum*)	*not present*	*common* November-March	adult area year-round summer spawning	not present in study area
Red drum (*Sciaenops ocellatus*)	*no data*	*common* year-round	adult area year-round	spawning area fall and winter - spawn in shallow coastal waters
Gag grouper (*Mycteroperca microlepis*)	*not present*	*not present*	adult occurrence	not present
Scamp (*Mycteroperca phenax*)	*not present*	*not present*	adult occurrence	no present in study area
Red snapper (*Lutjanus campechanus*)	*not present*	*not present*	not present in study area	nursery area year-round
Gray snapper (*Lutjanus griseus*)	*not present*	*not present*	major adult area year-round spawn June to August	nursery area
Lane snapper (*Lutjanus synagris*)	*not present*	*not present*	not present in study area	nursery area
Greater amberjack (*Seriola dumerilli*)	*not present*	*not present*	adult area year-round year-round spawning	nursery area year-round
King mackerel (*Scomberomorus cavalla*)	*not present*	*not present*	adult area year-round spawn May to November	nursery area year-round
Spanish mackerel (*Scomberomorus maculatus*)	*common* April-October *rare* November-March	*rare* July-October	adult area year-round	spawning area summer and fall nursery area year-round
Cobia (*Rachycentron canadum*)	*not present*	*not present*	adult area summer spawn in spring and summer	nursery area year-round

are associated with silt, muddy sand, and sandy substrates (GMFMC, 2004). Juvenile brown shrimp are common within the Brazos River estuary year-round.

Larval brown shrimp feed on phytoplankton and zooplankton. Postlarvae brown shrimp feed on phytoplankton, epiphytes, and detritus. Juvenile and adult brown shrimp prey on amphipods, polychaetes, and chironomid larvae, but graze on algae and detritus (Pattillo et al., 1997).

White Shrimp: White shrimp inhabit Gulf and estuarine waters and are pelagic or demersal, depending on their life stage. Their eggs are demersal and larval stages are planktonic and both occur in nearshore Gulf waters. Postlarvae migrate into estuaries through passes from May to November with most migration occurring in June and September. Migration is in the upper 6.5 ft of the water column at night and at mid-depths during the day. Postlarval white shrimp become benthic once they reach the estuary. Here they seek shallow water with mud or sand bottoms high in organic detritus or rich marsh where they develop into juvenile white shrimp. Postlarvae and juveniles prefer mud or peat bottoms with large quantities of decaying organic matter or SAV. Densities are usually highest along marsh edge and in SAV, followed by marsh ponds and channels, inner marsh, and oyster reefs. White shrimp juveniles prefer salinities of less than 10 ppt and occur in tidal rivers and tributaries. As white shrimp juveniles mature, they migrate to coastal areas where they mature and spawn. Adult white shrimp are demersal and inhabit soft mud or silt bottoms (GMFMC, 2004). Adult and juvenile white shrimp are common to highly abundant in the Brazos River estuary throughout the year. Adult white shrimp also occur throughout the Gulf to depths of about 131 ft.

White shrimp larvae feed on phytoplankton and zooplankton. White shrimp postlarvae feed on phytoplankton, epiphytes, and detritus. Juvenile and adult white shrimp prey on amphipods, polychaetes, and chironomid larvae, but also graze on algae and detritus (Pattillo et al., 1997).

Pink Shrimp: Pink shrimp inhabit Gulf and estuarine waters and are pelagic or demersal, depending on their life stage. After spawning offshore, postlarval pink shrimp recruitment into the estuaries occurs in the spring and fall through passes. Juveniles can be found in SAV meadows where they burrow into the substrate; however, postlarvae, juvenile, and adults may prefer a mixture of course sand/shell/mud. Densities of pink shrimp are lowest or absent in marshes, low in mangroves, and greatest near or in SAV. Adults occur offshore in depths of 30 to 145 ft and prefer substrates of coarse sand and shell (GMFMC, 2004). Juvenile pink shrimp are common from November through March in the Brazos River estuary.

Pink shrimp feed on phytoplankton and zooplankton. Postlarvae feed on phytoplankton, epiphytes, and detritus. Juveniles and adults prey on amphipods, polychaetes, and chironomid larvae but also on algae and detritus (Patillo et al., 1997). The habitat of these prey is essentially the same as that required by shrimp, estuarine, and marine.

Red Drum: Red drum occupy a variety of habitats, ranging from offshore depths of 131 ft to very shallow estuarine waters. Spawning occurs in the Gulf near the mouths of bays and inlets during the fall and early winter. Eggs usually hatch in the Gulf and larvae are transported with tidal currents into the estuaries where they mature. Adult red drum use estuaries, but tend to migrate offshore where they spend most of their adult life. Red drum occur over a variety of substrates including sand, mud, and oyster reefs and can tolerate a wide range of salinities (GMFMC, 2004).

Estuaries are especially important to larval, juvenile, and subadult red drum. Juvenile red drum are most abundant around marshes, preferring quiet, shallow, protected waters over mud substrate or among SAV. Subadult and adult red drum prefer shallow bay bottoms and oyster reefs (GMFMC, 2004). Adult red drum that migrate into the Gulf are pelagic.

Estuaries are also important for the prey of larval, juvenile, and subadult red drum. Red drum larva feed primarily on shrimp, mysids, and amphipods, while juvenile red drum prefer fish and crabs. Adult red drum feed primarily on shrimp, blue crab, striped mullet, and pinfish (GMFMC, 2004). Within the Brazos River estuary, juvenile red drum are common year-round.

Gag Grouper: Gag grouper are demersal and are most common in the eastern Gulf. Eggs are pelagic, and are spawned from December through April. Larvae are pelagic and most abundant in the early spring. Postlarvae and pelagic juveniles move through inlets into high salinity estuaries from April through May, where they become benthic and settle into grass flats and oyster beds. Older juveniles move offshore in the fall to shallow reef habitat in depths of 3 to 165 ft. Adults prefer depths of 33 to 328 ft, and utilize hard bottoms, oil platforms, and artificial reefs. Spawning occurs on the west Florida shelf from December through April (GMFMC, 2004).

Gag grouper feed on estuarine-dependent organisms such as shrimp, small fish, and crabs during their juvenile stages. As they mature and move offshore, they become opportunistic predators, feeding on a variety of fish and crustaceans (GMFMC, 2004). Adult gag grouper occur in Gulf waters within the study area.

Scamp: Scamp are demersal and widely distributed on shelf areas of the Gulf. Scamp eggs and larvae are pelagic and are spawned offshore in the spring. Juvenile scamp occur on shallow, nearshore hard bottoms and reefs in depths of 40 to 620 ft. Scamp spawn in aggregations from late February to early June.

Juvenile scamp feed on estuarine-dependent organisms such as shrimp, small fish, and crabs. As they mature and move offshore, they become opportunistic predators, feeding on a variety of fish and crustaceans (GMFMC, 2004). Adult scamp occur in Gulf waters within the study area.

Red Snapper: Red snapper are demersal and found over sand and rock substrates around reefs, and underwater objects to depths of 656 ft. However, adult red snapper prefer depths ranging from 131 to 360 ft (GMFMC, 2004). Spawning occurs in the Gulf from May to October, at depths of 60 to 122 ft over fine sand substrate. Larvae, postlarvae and early juveniles occur from July through November in shelf waters. Early and late juveniles are often associated with underwater structures or small burrows, but are also abundant over barren sand and mud bottoms.

Juvenile red snapper feed on shrimp, but after age one, prey primarily on fish and squid. Of the vertebrates consumed, most are not obligate reef dwellers, indicating that red snapper feed away from reefs (GMFMC, 2004). Juvenile red snapper occur in the Gulf waters within the study area.

Gray Snapper: Gray snapper can be demersal, structure, or mid-water dwellers inhabiting marine, estuarine, and riverine habitats. They inhabit depths to about 550 ft in the Gulf. Juvenile gray snapper are common in shallow water around SAV while adult gray snapper tend to congregate in deeper Gulf waters around natural and artificial reefs. Spawning occurs in the Gulf from June to August around structures and shoals. Their eggs are pelagic and the larvae are planktonic, both occurring in Gulf shelf waters and near coral reefs. Postlarvae migrate into the estuaries and are most abundant over *Halodule* and *Syringodium* grassbeds. Juveniles seem to prefer *Thalassia* grassbeds, seagrass meadows, marl bottoms, and mangrove roots, and are found in estuaries, bayous, channels, grassbeds, marshes, mangrove swamps, ponds and freshwater creeks (GMFMC, 2004).

Juvenile gray snapper feed on estuarine-dependent organisms such as shrimp, small fish, and crabs. Gray snapper are classified as opportunistic carnivores at all life stages (Pattillo et al., 1997). In estuaries, juvenile gray snapper feed on shrimp, larval fish, amphipods, and copepods. Adult gray snapper feed primarily on fish, but smaller individuals will prey on crustaceans (GMFMC, 2004). Adult and juvenile gray snapper are found in the Gulf waters of the study area.

Lane Snapper: Lane snapper are demersal, occurring over all substrate types, but are most commonly found near coral reefs and sandy bottoms. Spawning occurs in Gulf waters from March through September. Nursery areas include mangrove and grassy estuarine habitats in southern Texas and Florida and shallow waters with sand and mud bottoms along all Gulf states. Juvenile lane snapper appear to favor grass flats, reefs, and soft bottoms to depths of 66 ft. Adult lane snapper occur offshore in depths ranging from 13 to 433 ft near sand bottoms, natural channels, banks, and artificial and natural structures (GMFMC, 2004).

Juvenile lane snapper feed on estuarine-dependent organisms such as shrimp, small fish, and crabs. Lane snapper are considered to be unspecialized, opportunistic predators, feeding on a variety of crustaceans and fish. However, adult lane snapper tend to prefer fish (GMFMC, 2004). Juvenile lane snapper are found in estuaries and Gulf waters within the study area.

Greater Amberjack: Greater amberjack occur throughout the Gulf to depths of 1,300 ft. Adults are pelagic and epibenthic, occurring near reefs and artificial structures. Spawning occurs offshore, and juvenile greater amberjack are associated with floating Sargassum and debris (GMFMC, 2004). Adult and juvenile greater amberjack are found in the Gulf within the study area.

King Mackerel: King mackerel are pelagic and found in Gulf waters from nearshore to 655 ft. Spawning occurs in the Gulf from May to October. Eggs are pelagic occurring over depths of 98 to 590 ft. Nursery areas are located in marine waters with juveniles only occasionally entering estuaries (GMFMC, 2004).

While estuaries are important for most king mackerel prey, they feed on a variety of fishes, extensively utilizing herrings. Squid, shrimp, and other crustaceans are also prey for by king mackerel. Adult and juvenile king mackerel are found in the Gulf within the study area.

Spanish Mackerel: Spanish mackerel are pelagic, inhabiting depths to 245 ft throughout the coastal zone of the Gulf. Adult Spanish mackerel are usually found from nearshore to the edge of the continental shelf. However, they may also migrate seasonally into estuaries with high salinity, but this migration is infrequent and rare. Spawning occurs in the Gulf from May through October. Larvae typically occur in the Gulf in depths ranging from 30 to 275 ft. Juveniles inhabit the Gulf surf and sometimes estuarine habitats. However, juvenile Spanish mackerel prefer marine salinities and are not considered estuarine-dependent. Adult and juvenile Spanish mackerel are found in the Gulf year-round within the study area. Juvenile Spanish mackerel prefer clean sand bottoms, but the substrate preferences of the other life stages are unknown (GMFMC, 2004).

While Spanish mackerel rarely use estuarine environments, estuaries are important for most of their prey. They feed on a variety of fishes, extensively herrings. Squid, shrimp, and other crustaceans are also fed upon by Spanish mackerel.

Cobia: Cobia are large, pelagic fish, occurring from nearshore to depths of 131 ft near artificial and natural structures, including floating objects. In the study area, cobia occur only in the Gulf and do not use estuarine waters (GMFMC, 2004).

However, estuaries are important for most cobia prey. They feed on a variety of fishes, extensively herrings. Squid, shrimp, and other crustaceans are also prey for cobia (GMFMC, 2004).

3.15 ENDANGERED AND THREATENED SPECIES

Congress enacted the Endangered Species Act (ESA) [16 U.S.C. 1531 et. Seq.] of 1973, as amended, to provide a program for the preservation of endangered and threatened species and to provide protection for the ecosystems upon which these species depend for their survival. All Federal agencies are required to implement protection programs for these designated species and to use their authorities to further the purposes of the act. The FWS and the NMFS are the primary agencies responsible for implementing the ESA. The FWS is responsible for birds and terrestrial and freshwater species, while the NMFS is responsible for nonbird marine species.

An endangered species is one that is in danger of extinction throughout all or a significant portion of its range in the U.S. A threatened species is one likely to become endangered within the foreseeable future throughout all or a significant portion of its range. This assessment addresses State-listed threatened and endangered species; however, the ESA does not protect these species. Only those species that FWS or NMFS lists as endangered or threatened have complete Federal protection under the ESA. Inclusion on the following lists does not imply that a species occurs in the study area, but only acknowledges the potential for occurrence. The FWS (2006a) and TPWD Natural Diversity Database (NDD, 2005) provided county-level lists of endangered and threatened species of potential occurrence in Brazoria County. In addition, NDD (2006) provided digital map data presenting specific locations of listed species within the study area.

3.15.1 Flora

TPWD's official state list of endangered and threatened species includes the same species that FWS lists as endangered or threatened. FWS (2006a) currently identifies 30 plant species as endangered or threatened in Texas; however, no Federally or State-listed plant species are of potential occurrence in Brazoria County (NDD, 2005; FWS, 2006a).

3.15.2 Wildlife

Table 3.15-1 lists wildlife taxa that FWS and TPWD consider as endangered or threatened and that have a geographic range that may include Brazoria County. As noted above, inclusion on the following list does not imply that a species occurs in the study area, but only acknowledges the potential for occurrence. The following paragraphs present distributional data concerning each Federally or State-listed species, along with a brief evaluation of the potential for the species to occur within the study area.

3.15.2.1 Birds

FWS and/or TPWD identify 12 Federally and/or State-listed endangered and threatened bird species as occurring or potentially occurring in the study area. Some of these are inland species that are not likely to occur in the study area, while others are migrants that pass though the region seasonally. Others may occur as breeding birds, permanent residents, or post-nesting visitors. The following paragraphs present descriptions of Federally listed species, followed by descriptions of State-listed species.

The Federally and State-listed endangered Attwater's greater prairie-chicken (*Tympanuchus cupido attwateri*), a subspecies of the greater prairie-chicken (*T. cupido*), was formerly abundant on the coastal prairies of Texas, but fewer than 50 individuals remain and it is arguably the most endangered species in Texas (Schroeder and Robb, 1993; Lockwood and Freeman, 2004). The greater prairie-chicken historically inhabited native prairie and oak savannahs throughout central North America, as well as the coastal plain from Massachusetts to Virginia. Current populations are restricted to native prairie intermixed with cropland, mainly in mid-western states. The Attwater's subspecies was once a common resident of the Gulf coastal prairies of Texas and Louisiana, but currently only two wild populations remain at refuges in Colorado and Galveston counties (FWS, 1992b; Lockwood and Freeman, 2004). A third wild population in Refugio County was recently extirpated (Lockwood and Freeman, 2004). This species would not occur within the study area because of the lack of prairie habitat and its extremely limited range.

The Federally and State-listed endangered brown pelican (*Pelecanus occidentalis*) is an uncommon to common resident along the Texas Gulf Coast, occasionally wandering inland during post-breeding in late

TABLE 3.15-1

ENDANGERED AND THREATENED WILDLIFE SPECIES OF POSSIBLE OCCURRENCE IN BRAZORIA COUNTY, TEXAS[1]

Common Name[2]	Scientific Name[2]	Status[3]	
		FWS	TPWD
BIRDS			
Attwater's greater prairie-chicken	*Tympanuchus cupido attwateri*	E	E
Brown pelican	*Pelecanus occidentalis*	E	E
Whooping crane	*Grus americana*	E	E
Bald eagle	*Haliaeetus leucocephalus*	T-PDL	T
Piping plover	*Charadrius melodus*	T	T
Arctic peregrine falcon	*Falco peregrinus tundrius*	DL	T
Reddish egret	*Egretta rufescens*	NL	T
White-faced ibis	*Plegadis chihi*	NL	T
Wood stork	*Mycteria americana*	NL	T
Swallow-tailed kite	*Elanoides forficatus*	NL	T
White-tailed hawk	*Buteo albicaudatus*	NL	T
Sooty tern	*Sterna fuscata*	NL	T
MAMMALS			
Ocelot[4]	*Leopardus pardalis*	E	E
Jaguarundi[4]	*Herpailurus yaguarondi*	E	E
West Indian manatee[4]	*Trichechus manatus*	E	E
Louisiana black bear	*Ursus americanus luteolus*	T	T
Black bear	*Ursus americanus*	T/SA; NL	T
Blue Whale	*Balaenoptera musculus*	E	
Finback Whale	*Physeter macrocephalus*	E	
Right Whale	*Eubalaena glacialis*	E	
Sei Whale	*Balaenoptera borealis*	E	
REPTILES			
Leatherback sea turtle	*Dermochelys coriacea*	E	E
Hawksbill sea turtle	*Eretmochelys imbricata*	E	E
Kemp's ridley sea turtle	*Lepidochelys kempii*	E	E
Loggerhead sea turtle	*Caretta caretta*	T	T
Green sea turtle	*Chelonia mydas*	T	T
Texas horned lizard	*Phrynosoma cornutum*	NL	T
Timber rattlesnake	*Crotalus horridus*	NL	T
Smooth greensnake	*Opheodrys vernalis*	NL	T

[1]According to NDD (2005) and FWS (2006).

[2]Nomenclature and taxonomic orders follow AOU (1998, 2000, 2002, 2003, 2004, and 2005), Crother et al. (2000, 2001, and 2003), Baker et al. (2003), NDD (2005), and FWS (2006a).

[3]E – Endangered; T – Threatened; T/SA – Threatened because of similarity of appearance to another listed species; DL – Federally delisted; PDL – Proposed for delisting; NL – Not listed.

[4]Listed as present in Brazoria County by TPWD but not by FWS/NMFS. Not included in BA.

summer and fall (Lockwood and Freeman, 2004). Brown pelicans breed on barrier, natural estuarine, or dredge-spoil islands (Shields, 2002). The species is an uncommon resident in the general area (FWS, n.d.), but likely occurs in the open water and barrier island habitats in the study area.

The Federally and State-listed endangered whooping crane (*Grus americana*) is a large wading bird that in the last 50 years has returned from the brink of extinction. Only three wild populations of whooping crane exist, the largest of which is the Aransas/Wood Buffalo population, which breeds in Wood Buffalo National Park in northern Canada and migrates annually to Aransas NWR and adjacent areas of thecentral Texas coast in Aransas, Calhoun, and Refugio counties where it winters (FWS, 1995; Lewis, 1995). Other smaller wild populations include the experimental Rocky Mountain population and the nonmigratory Florida population (Lewis, 1995). In Texas, the whooping crane's wintering habitat includes estuarine marshes, shallow bays, and tidal flats, and occasionally nearby rangelands or farmlands. According to FWS (1995), Brazoria County is within the species' migration corridor; however, the species is unlikely to occur in the study area because of the absence of suitable wintering habitat. NDD (2006) indicates documented records of whooping cranes from marshes west of the Brazos River; however, these likely represent vagrant birds and no wintering populations are present in the study area.

The Federally and State-listed threatened bald eagle (*Haliaeetus leucocephalus*) is present year-round in Texas, including breeding, wintering, and migrating birds. In Texas, bald eagles breed along the Gulf Coast and on major inland lakes and reservoirs in the eastern two-thirds of the state. Additional numbers of bald eagles winter in these habitats, as far west as the Trans-Pecos. Bald eagles prefer large bodies of water surrounded by tall trees or cliffs, which they use as nesting sites. In 1999, the FWS proposed to remove the bald eagle from the list of endangered and threatened wildlife (64 FR 128; 36453–36464; 6 July 1999); however, the FWS has yet to make a final decision on the delisting. If delisted, the bald eagle would still receive Federal protection under provisions of the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act. Ortego (2002) identified 155 nesting territories statewide, of which at least four currently exist in Brazoria County. Ortego (2002) does not disclose the locations of bald eagle nests; therefore, the exact locations of the nests are unknown. NDD (2006) indicates an active bald eagle territory north of Freeport, between Clute and Oyster Creek (TPWD nest #020-8A). The species is likely present in the general area at some time during the year; however, no suitable nesting habitat is present in the study area.

The Federally and State-listed threatened piping plover (*Charadrius melodus*) is a small shorebird that inhabits coastal beaches and tidal flats. Approximately 35% of the known global population of piping plovers winters along the Texas Gulf Coast, where they spend 60 to 70% of the year (Campbell, 1995; Haig and Elliott-Smith, 2004). The piping plover population that winters in Texas breeds on the northern Great Plains and around the Great Lakes. The species is a common migrant and rare to uncommon winter resident on the upper Texas coast (Richardson et al., 1998; Lockwood and Freeman, 2004). FWS (n.d.) indicates that the piping plover is an uncommon migrant and winter resident in Brazoria County. Because of a lawsuit, FWS has designated critical habitat for the species in its nesting and wintering range (65 FR 41781–41812, 6 July 2000). Designation of critical habitat became final on 10 July 2001 (66 FR 17;

36038–36143). Critical Habitat Unit TX-36 encompasses approximately 388 acres between the mouth of the Brazos River and Farm-to-Market Road (FM) 1495 and includes Bryan Beach and adjacent beach habitat (66 FR 17; 36142, 10 July 2001). NDD (2006) maps show no documented records within the study area.

The FWS recently removed the peregrine falcon (*Falco peregrinus*) from the Federal list of endangered and threatened species, but the Arctic subspecies (*Falco peregrinus tundrius*) retains its State-listed status of threatened in Texas. The Arctic subspecies of peregrine falcon is an uncommon migrant statewide and an uncommon winter resident along the Texas Gulf Coast, where it typically occurs near bays and estuaries (Lockwood and Freeman, 2004). Peregrine falcons may occur within the study area during migration; however, no suitable nesting or wintering habitat is present in the study area. NDD mapping indicates no documented records from the study area; however, the species may occur in winter or as a transient during migration.

The State-listed threatened reddish egret (*Egretta rufescens*) is a resident of brackish marshes, tidal flats, and shallow salt lakes along the Texas Gulf Coast, where they nest in brushy yucca and prickly pear thickets on dry coastal islands (Oberholser, 1974; Lowther and Paul, 2002; Lockwood and Freeman, 2004). Reddish egrets are uncommon year-round residents on the upper Texas coast, including Brazoria County (FWS, n.d.; Richardson et al., 1998). Reddish egrets are likely present in the general area.

The State-listed threatened white-faced ibis (*Plegadis chihi*) is a medium-sized wading bird that inhabits freshwater marshes, sloughs, and irrigated rice fields, but also frequents brackish and saltwater habitats. White-faced ibis are permanent residents along the Texas Gulf Coast; however, nesting records exist for many scattered inland localities (Ryder and Manry, 1994; Lockwood and Freeman, 2004). The species is a common migrant/summer resident and uncommon winter resident on the upper Texas coast (Richardson et al., 1998). NDD (2006) indicates no documented records within the study area; however, the species is likely present year-round in the general area.

The State-listed threatened wood stork (*Mycteria americana*) is an uncommon to locally common post-breeding visitor to coastal Texas and inland waters in east and central Texas (Lockwood and Freeman, 2004). Wood storks historically bred in North America along the Gulf Coast from east Texas to Florida, but their range has significantly declined since the 1960s and their North American breeding range is now restricted to Florida, Georgia, and South Carolina (Oberholser, 1974; Coulter et al., 1999). In Texas, wood storks typically occur near freshwater or saltwater wetlands, lakes, or along rivers and streams. The FWS lists the wood stork as Federally endangered in Florida, Alabama, Georgia, North Carolina, and South Carolina, but not in Texas. Wood storks are uncommon to common in summer and fall along the upper Texas coast (FWS, n.d.; Richardson et al., 1998). The species likely occurs in the study area during summer and fall.

The State-listed threatened swallow-tailed kite (*Elanoides forficatus*) is a medium-sized raptor that historically occurred along the coastal plains, interior lowlands, and riparian areas throughout the southeastern U.S. and Mississippi River Valley, west to central Texas (Meyer, 1995). Beginning in the late 1800s and early 1900s, this species' U.S. range dramatically decreased, likely because of forestry practices, which resulted in the loss of tall trees used for nesting. Today, swallow-tailed kites breed primarily in Florida, with scattered breeding populations in South Carolina, Georgia, Alabama, Mississippi, Louisiana, and southeastern Texas (Meyer, 1995). In Texas, the species is a rare to uncommon migrant throughout the eastern third of the state, with occasional migration records west to the eastern Edwards Plateau (Lockwood and Freeman, 2004). The species is a rare migrant in Brazoria County, with the majority of records occurring between April and June (Richardson et al., 1998; Shackelford and Simons, 2000). NDD (2006) indicates no records within the study area; however, Shackelford and Simons (2000) indicate recent records of migrating birds, therefore, the species may occur in the study area as a migrant.

The State-listed threatened white-tailed hawk (*Buteo albicaudatus*) is an uncommon local resident on the Gulf coastal plain, from Harris County south to the Rio Grande (Lockwood and Freeman, 2004). White-tailed hawks inhabit coastal prairies and brushlands, as well as inland mesquite and oak savannahs (Farquhar, 1992; NDD, 2005). This species likely occurs in the general vicinity of the study area, particularly in inland areas with appropriate habitat.

The State-listed threatened sooty tern (*Sterna fuscata*) is a largely pelagic (open ocean) species that nests on isolated tropical and subtropical islands (Schreiber et al., 2002). The species is a rare and local summer resident along the middle and lower Texas Gulf Coast from Matagorda County to Cameron County, where they nest in small numbers on natural and dredged material islands, particularly in the Laguna Madre (Oberholser, 1974; Lockwood and Freeman, 2004). Sooty terns are rare in summer along the upper Texas Coast (Richardson et al., 1998). It is unlikely that this oceanic species would regularly occur in the study area; however, their occurrence is possible.

3.15.2.2 Mammals

The ocelot is a medium-sized spotted cat that historically inhabited dense thornscrub and thickets in southwest Texas, along the Texas Gulf Coast, and in the Big Thicket of east Texas, but currently occurs only in small, remnant patches of dense thornscrub in the Lower Rio Grande Valley (Schmidly, 2004). The current Texas ocelot population likely consists of 80 to 120 individuals, which occur in two isolated populations in several south Texas counties (Schmidly, 2004). At least one historic record of an ocelot exists from Brazoria County (Schmidly, 2004); however, because of the limited terrestrial habitat and the fact that much of the area is developed, it is highly unlikely that ocelots would occur in the study area.

The jaguarundi is a secretive, small slender-bodied cat that inhabits dense thornscrub and brushland in Cameron, Hidalgo, Starr and Willacy counties (Schmidly, 2004). The jaguarundi is the least common felid in Texas and the current Texas population likely consists of no more than 15 individuals (Schmidly, 2004). NDD (2006) indicates a 1991 class II record (reliable observation) from Brazoria NWR. Schmidly

(2004) indicates no recent documented records of jaguarundis exist from Brazoria County and it is highly unlikely that this extremely rare species would occur in the study area.

The Federally listed endangered West Indian manatee (*Trichechus manatus*) is an aquatic mammal which inhabits brackish water bays, large rivers, and salt water (Davis and Schmidly, 1994), and feeds upon submergent, emergent, and floating vegetation with the diet varying according to plant availability (O'Shea and Ludlow, 1992). Historically the manatee inhabited the Laguna Madre, Gulf of Mexico, and tidally influenced portions of rivers. It is currently, however, extremely rare in Texas waters and the most recent sightings are likely individuals migrating or wandering from Mexican waters. Historical records from Texas waters include Cow Bayou, Sabine Lake, Copano Bay, the Bolivar Peninsula, and the mouth of the Rio Grande (Schmidly, 2004). In May 2005, a live manatee was photographed in the Laguna Madre near Port Mansfield (Blankinship, 2005). Although the West Indian manatee is chiefly a marine species, its occurrence in the study area is unlikely.

TPWD lists the Louisiana black bear as a potentially occurring species in Nacogdoches and San Augustine counties, along with the nominate American black bear, because of its similarity in appearance to the Louisiana subspecies. The Louisiana black bear historically inhabited east Texas, Louisiana, and southern Mississippi, but now occurs only in small numbers in Mississippi and Louisiana (FWS, 1992c). The last Texas Pineywoods record of native black bear is from the late 1950s, near the town of Livingston in Polk County (Fleming, 1980). There are periodic reports of black bears from various counties of east Texas; however, these bears most likely represent individuals dispersing from neighboring areas in Louisiana (Taylor, 2000). According to Garner (1995), Louisiana black bears historically ranged as far east as Aransas and Refugio counties, which suggests they may have occurred in Brazoria County; however, no recent documented sightings of black bears exist from the Texas Gulf Coast. It is unlikely that either subspecies of black bear would occur in the study area.

The blue whale (*Balaenoptera musculus*) is listed as endangered under the ESA. This species inhabits and feeds in both coastal and pelagic environments. The distribution of blue whales is presumably governed largely by food requirements. Populations move toward the poles in the spring to take advantage of high zooplankton production during summer months. Blue whales move toward the subtropics in the fall to reduce energy expenditure while fasting and engage in reproductive activities in warmer waters. The blue whale is considered only an occasional visitor in the U.S. Atlantic waters. This may represent the southern limit of the western North Atlantic blue whales feeding range, although the actual southern limit of its range is unknown. Some records have suggested an occurrence of this species in waters near Florida and in the Gulf of Mexico (NMFS, 2006a). The blue whale is not expected to occur in the study area.

The finback or fin whale (*Balaenoptera physalus*) is listed as endangered under the ESA. Finback whales are found offshore and tend to be nomadic. The high food availability in high latitudes and cold currents make it a desired habitat for the finback whale. In the fall these whales migrate several thousand miles to equatorial waters. Fin whales fast almost completely in the winter, living off fat reserves. Mating occurs throughout the winter and young are born a year later between December and April (New York State

Department of Environmental Conservation [NYSDEC], 2006). The finback whale is not expected to occur in the study area.

The sperm whale (*Physeter macrocephalus*) is endangered throughout its range due mostly to overexploitation from commercial whaling during the past two centuries. This species is found throughout the world's oceans in deep waters between about 60° N and 60° S latitudes. Sperm whales tend to inhabit areas with water depths of 1,970 ft or more, and are uncommon in waters less than 985 ft deep. Their distribution is dependent on their food source and suitable conditions for breeding, and varies with the sex and age composition of the group. Sperm whale migrations are not as predictable or well understood. In some mid-latitudes, there seems to be a general trend to migrate north and south depending on the seasons (whales move poleward in the summer). However, in tropical and temperate areas, there appears to be no obvious seasonal migration (NMFS, 2006a). The sperm whale is not expected to occur in the study area.

The right whale (*Eubalaena glacialis*) has been listed as endangered under the ESA since its passage in 1973. This species is among the rarest of all marine mammal species. Historically, right whales probably occurred in coastal and continental shelf waters of all the world's oceans from temperate to subpolar latitudes. Right whales were hunted to near extinction by the nineteenth century. The distribution of right whales in the northern hemisphere is strongly correlated to the distribution of calanoid copepods, their primary food source (NMFS, 2006a). North Atlantic right whale sightings have been reported as far south as the Gulf of Mexico. A female and calf were recently (on 16 January 2006) observed in Corpus Christi Bay, Texas (personal communication with K. Baker, NOAA Fisheries-Protected Resources Division).

The main factor limiting right whales is their critically low population size, the result of extensive exploitation since the beginning of commercial whaling. Other principal threats include incidental collisions with vessels and entanglement in fishing gear. The right whale is not expected to occur in the study area (NMFS, 2006a).

The Sei whale (*Balaenoptera borealis*) is currently designated as an endangered species under the ESA. The Sei whale inhabits, breeds, and feeds in open oceans, and is usually restricted to more temperate waters. These whales migrate several thousand miles to the equator in the fall. The mating season lies between April to December, during which they fast or forage minimally, living off their fat reserves. Sei whales are found in the North Atlantic Ocean ranging from the south of Iceland to the northeastern Venezuelan coast, and northwest to the Gulf. Sei whales are also known to occur near Cuba, the Virgin Islands and infrequently in U.S. waters (NYSDEC, 2006). Sei whales of the U.S. waters are grouped into four stocks: East North Pacific, Hawaii, Nova Scotia (formerly part of Western North Atlantic), and Western North Atlantic stocks. Due to lack of data there are currently no trends on the Sei whale population of most of the stocks or on their recovery rate. The protection status accorded to the Sei whale since 1976 might have increased the population; however, unauthorized hunting, incidental ship strikes and gillnet mortality (NMFS, 2006a) make this uncertain. The Sei whale is not expected to occur in the study area.

3.15.2.3 Reptiles

Five species of sea turtle occur in Texas waters: Kemp's ridley sea turtle (*Lepidochelys kempii*), hawksbill sea turtle (*Eretmochelys imbricata*), leatherback sea turtle (*Dermochelys coriacea*), loggerhead sea turtle (*Caretta caretta*), and green sea turtle (*Chelonia mydas*). Kemps' ridley, the hawksbill, and the leatherback are Federally and State-listed as endangered, while the loggerhead and green sea turtle are Federally and State-listed as threatened. The loggerhead and Kemps' ridley are the two most common species in Texas waters and the leatherback sea turtle is the rarest. All except the leatherback turtle have nested on Texas beaches, with the vast majority of nests belonging to the Kemp's ridley (NMFS, 2006b; National Park Service [NPS], 2006; Shaver, 2006).

The Kemp's ridley sea turtle inhabits shallow coastal and estuarine waters, usually over sand or mud bottoms. Adults are primarily restricted to the Gulf of Mexico, although juveniles may range throughout the Atlantic Ocean since they have been observed as far north as Nova Scotia (Musick, 1979) and in coastal waters of Europe (Brongersma, 1972). Almost the entire population of Kemp's ridleys nests on an 11-mile stretch of coastline near Rancho Nuevo, Tamaulipas, Mexico, approximately 190 miles south of the Rio Grande. Sporadic nesting has been reported from Mustang Island, Texas, southward to Isla Aquada, Campeche. Kemp's ridley occurs in Texas in small numbers and in many cases may well be in transit between crustacean-rich feeding areas in the northern Gulf of Mexico and breeding grounds in Mexico. It has nested sporadically in Texas in the last 50 years. The number of nestings in Texas, however, has increased over the last decade from 4 nests in 1995 to 51 nests in 2005, 28 of which were from the Padre Island National Seashore (Shaver, 2006; NPS, 2006). Several of the ridley nests were from headstarted individuals. Such nestings, together with the proximity of the Rancho Nuevo rookery, probably account for the occurrence of hatchlings and subadults in Texas. Kemp's ridley has been recorded from the study area. In 1994, a headstarted ridley was accidentally caught by a fisherman on a rod and reel in the GIWW and released alive (NDD, 2006). This species has also nested in the study area. One nest was found on Quintana Beach in 2002 and another was found near Surfside Beach in 2003 (Yeargan, 2006).

The loggerhead sea turtle is widely distributed in tropical and subtropical seas, being found in the Atlantic Ocean from Nova Scotia to Argentina, Gulf of Mexico, Indian and Pacific oceans (although it is rare in the eastern and central Pacific) and the Mediterranean Sea (Rebel, 1974; Ross, 1982; Iverson, 1986). In the continental U.S., loggerheads nest along the Atlantic coast from Florida to as far north as New Jersey (Musick, 1979) and sporadically along the Gulf coast, including Texas. Like the worldwide population, the population of loggerheads in Texas has declined. The loggerhead is the most abundant turtle in Texas marine waters, preferring shallow inner continental shelf waters and occurring only very infrequently in the bays. It is often seen around offshore oil rig platforms, reefs, and jetties. Loggerheads are probably present year-round but are most noticeable in the spring when one of their food items, the Portuguese man-o-war, is abundant. Loggerheads constitute a major portion of the dead or moribund turtles washed ashore (stranded) on the Texas coast each year. A large proportion of these deaths is the result of accidental capture by shrimp trawlers, where caught turtles drown and their bodies are dumped overboard.

In 1999, two loggerhead nests were confirmed in Texas, while in 2000, five loggerhead nests were confirmed (Shaver, 2000). For the last five years, up to five loggerhead nests per year have been recorded from the Texas coast (Shaver, 2006). This species has been recorded from the study area. Between 1995 and 2000, eight loggerheads were caught in Freeport Harbor, and during the Freeport Harbor Project (July 13 to September 24, 2002), one loggerhead was captured by a relocation trawler (NMFS, 2003).

The green sea turtle is a circumglobal species in tropical and subtropical waters. In U.S. Atlantic waters, it occurs around the U.S. Virgin Islands, Puerto Rico, and continental U.S. from Massachusetts to Texas. Major nesting activity occurs on Ascension Island, Aves Island (Venezuela), Costa Rica, and in Surinam. Relatively small numbers nest in Florida, with even smaller numbers in Georgia, North Carolina, and Texas (NMFS and FWS, 1991; Hirth, 1997). The green turtle in Texas inhabits shallow bays and estuaries where its principal foods, the various marine grasses, grow (Bartlett and Bartlett, 1999). While green turtles prefer to inhabit bays with seagrass meadows, they may also be found in bays that are devoid of seagrasses. The green turtles in these Texas bays are mainly small juveniles. Adults, juveniles, and even hatchlings are occasionally caught on trotlines or by offshore shrimpers or are washed ashore in a moribund condition.

Green turtle nests are rare in Texas. Five nests were recorded at the Padre Island National Seashore in 1998, none in 1999, and one in 2000 (Shaver, 2000). For the last five years, up to five nests per year have been recorded from the Texas coast (Shaver, 2006). Since long migrations of green turtles from their nesting beaches to distant feedings grounds are well documented (Meylan, 1982; Green, 1984), the adult green turtles occurring in Texas may be either at their feeding grounds or in the process of migrating to or from their nesting beaches. The juveniles frequenting the seagrass meadows of the bay areas may remain there until they move to other feeding grounds or, perhaps, once having attained sexual maturity, return to their natal beaches outside of Texas to nest. This species is of potential occurrence in the study area.

The hawksbill sea turtle is circumtropical, occurring in tropical and subtropical seas of the Atlantic, Pacific, and Indian oceans (Witzell, 1983). This species is probably the most tropical of all marine turtles, although it does occur in many temperate regions. The hawksbill sea turtle is widely distributed in the Caribbean Sea and western Atlantic Ocean, with representatives of at least some life history stages regularly occurring in southern Florida and the northern Gulf of Mexico (especially Texas), south to Brazil (NMFS, 2006b). The hawksbill generally inhabits coastal reefs, bays, rocky areas, passes, estuaries, and lagoons, where it occurs at depths of less than 70 ft. Like some other sea turtle species, hatchlings are sometimes found floating in masses of marine plants (e.g., sargassum rafts) in the open ocean (National Fish and Wildlife Laboratory [NFWL], 1980). In the continental U.S., the hawksbill largely occurs in Florida where it is sporadic at best. In 1998 the first hawksbill nest recorded on the Texas coast was found at Padre Island National Seashore. This nest remains the only documented hawksbill nest on the Texas coast (NPS, 2006; Shaver 2006). Elsewhere in the western Atlantic, hawksbills nest in small numbers along the Gulf Coast of Mexico, the West Indies, and along the Caribbean coasts of Central and South America (Musick, 1979). Texas is the only state outside of Florida where hawksbills are encountered with any regularity. Most of these sightings involve posthatchlings and juveniles, and are primarily associated with stone jetties. These small turtles are believed to originate from nesting beaches in Mexico (NMFS, 2006b). This species is of potential occurrence in the study area.

The leatherback sea turtle is probably the most wide-ranging of all sea turtle species. It occurs in the Atlantic, Pacific and Indian oceans; as far north as British Columbia, Newfoundland, Great Britain and Norway; as far south as Australia, Cape of Good Hope, and Argentina; and in other water bodies such as the Mediterranean Sea (NFWL, 1980). The leatherback is mainly pelagic, inhabiting the open ocean, and seldom approaches land except for nesting (Eckert, 1992) or when following concentrations of jellyfish (TPWD, 2006), when it can be found in inshore waters, bays, and estuaries. It dives almost continuously, often to great depths. Leatherbacks nest primarily in tropical regions and only sporadically in some of the Atlantic and Gulf states of the continental U.S., with one nesting reported as far north as North Carolina (Schwartz, 1976). In the Atlantic and Caribbean, the largest nesting assemblages occur in the U.S. Virgin Islands, Puerto Rico, and Florida (NMFS, 2006b). No nests of this species have been recorded in Texas for at least 70 years (NPS, 2006); the last two, one from the late 1920s and one from the mid-1930s, were both from Padre Island (Hildebrand, 1982, 1986). Apart from occasional feeding aggregations such as the large one of 100 animals reported by Leary (1957) off Port Aransas in December 1956, or possible concentrations in the Brownsville Eddy in winter (Hildebrand, 1983), leatherbacks are rare along the Texas coast, tending to keep to deeper offshore waters where their primary food source, jellyfish, occurs (NMFS and FWS, 1992). A leatherback, however, was caught by a relocation trawler in a shipping channel approximately 1.5 miles north of Aransas Pass in 2003 (NMFS, 2003). This species is unlikely to occur in the study area.

The State-listed threatened Texas horned lizard (*Phrynosoma cornutum*) occurs throughout the western two-thirds of the state in a variety of habitats, but prefers arid to semi-arid habitats in sandy loam or loamy sand soils that support patchy bunch-grasses, cacti, yucca, and various shrubs (Henke and Fair, 1998; Dixon, 2000). Dixon (2000) shows historic records from Brazoria County; however, because of the limited terrestrial habitat it is unlikely they would occur in the study area.

The State-listed threatened timber rattlesnake (*Crotalus horridus*) typically inhabits dense thickets and brushy areas along the floodplains of major creeks and rivers throughout the eastern third of Texas. It occurs in a variety of habitats including floodplains and riparian areas, swamps, upland pine and deciduous woodlands, abandoned farmland, and limestone bluffs (Werler and Dixon, 2000). This rattlesnake is most active during the summer and fall, with some activity noted in spring and as late as December (Werler and Dixon, 2000). Documented records exist from Brazoria County (Dixon, 2000); however, it is unlikely the species would occur in the study area because of the lack of suitable habitat.

The State-listed threatened smooth greensnake (*Opheodrys vernalis*) is a rare, slender, nonvenomous snake that inhabits open short-grass prairies and meadows in the coastal plains of Austin, Chambers, Harris, and Matagorda counties (Tennant, 1985; Werler and Dixon, 2000). The smooth greensnake is one of the rarest serpents in Texas, known from less than 10 specimens in the aforementioned counties (Werler and Dixon, 2000). The Texas population of the species represents a relict population that is over

500 miles from the closest population in the northern U.S. (Werler and Dixon, 2000). Although Brazoria County is within the general distribution of the species (Dixon, 2000), the species is very rare and is unlikely to occur within the study area in considerable numbers.

3.15.2.4 Fish

The following fish species are not included in Table 3.15-1 because they are considered species of concern or candidate species (those species of concern that are actively being considered for listing as endangered or threatened) and are not currently offered formal protection under the ESA. However, they are included in the discussion below to address fish species considered as potentially in need of protection by the NMFS (2006c).

While the American eel (*Anguilla rostrata*) is not formally listed as threatened or endangered in Texas, it has been identified as a candidate species. This concern stems from general declines in the apparent numbers, which are believed to be largely due to main-stem impoundments on rivers (Haro et al., 2000). The American eel occurs primarily in the Great Lakes and rivers with open access to the Atlantic Ocean and Gulf of Mexico. The American eel is catadromous, spending most of its life in rivers while migrating to the sea to spawn. Spawning occurs in the Sargasso Sea and after spawning, it is thought that the adults die. The young develop while drifting as plankton in the open sea; when they become juveniles (often referred to as “glass eels”) they migrate into estuaries to mature. American eels are opportunistic carnivores, feeding on a vast array of animal life depending on the size of the eel and the availability of prey within a given habitat (Van Den Avyle, 1984). In Texas, records include American eels from the Red River to the Rio Grande in most large river systems, however it is unlikely this species will occur in the study area (Hubbs et al., 1991).

The dusky shark (*Carcharhinus obscurus*), also known as the bronze whaler or black whaler, was added to the NMFS species of concern list in 1997. It has a wide-ranging (but patchy) distribution in warm-temperate and tropical continental waters (NMFS, 2006c). It is coastal and pelagic in its distribution where it occurs from the surf zone to well offshore and from surface depths to 400 meters (Compagno, 1984). Because it apparently avoids areas of lower salinities, it is not commonly found in estuaries (Compagno, 1984; Musick et al., 1993). The dusky shark is not likely to occur in the study area.

The largetooth sawfish (*Pristis pristis*) is a sluggish demersal (bottom-dwelling) fish inhabiting near-shore marine, coastal, estuarine, and tidal freshwater habitats. It is listed as a species of concern due to declining stocks in recent decades, thought to be caused by incidental commercial catch and (mainly in inshore areas) habitat degradation (NMFS, 2006c). In the U.S., largetooth sawfish have most commonly been reported in the northern Gulf of Mexico, although records are sporadic. The species is somewhat more common in tropical areas. Since most of the records in the northern Gulf of Mexico are of adults, it is believed that spawning may be confined to more southern waters (McEachran and de Carvalho, 2002). The largetooth sawfish has been rarely reported in the Gulf and is not likely to occur in the study area (Hoese and Moore, 1998).

NMFS designated the night shark (*Carcharhinus signatus*) a species of concern in 1997. Data on this species are minimal because the shark is a deepwater species, exceeding 525 ft in depth. The shark has been reported in waters from Delaware south to Brazil, including the Gulf of Mexico. It has also been reported from West Africa. It was formerly abundant in deep waters off the northern coast of Cuba and the Straits of Florida (NMFS, 2006c). The night shark is not likely to occur in the study area.

NMFS designated the saltmarsh topminnow (*Fundulus jenkinsi*) as a species of concern in 1997. This rare species is restricted to coastal streams and adjacent bay shores on the western side of Galveston Bay and from Vermilion Bay to the Florida Panhandle. Usually found in low salinities, it has been taken from the Chandeleur Islands (Hoese and Moore, 1998). This species tends to live in salt marshes and brackish water, although it has been known to survive in freshwater. This species can also be found in shallow tidal meanders of Spartina marshes (NMFS, 2006c). In Texas, the saltmarsh topminnow is known only from Dickinsons Bayou near Galveston Bay and is not likely to occur in the study area (Hubbs et al., 1991).

The Atlantic and Gulf of Mexico populations of the sand tiger shark (*Odontspis taurus*) were added to the species of concern list in 1997. Sand tiger sharks have a broad inshore distribution. In the western Atlantic, this shark occurs from the Gulf of Maine to Florida, in the northern Gulf of Mexico, in the Bahamas and in Bermuda. Although first reported in Texas in the 1960s, this species does not seem to be uncommon. A cool temperate species, it is more common north of Cape Hatteras (Hoese and Moore, 1998). They are generally coastal, usually found from the surf zone down to depths around 75 ft. However, they may also be found in shallow bays, around coral reefs and to depths of 600 ft on the continental shelf. They usually live near the bottom, but may also be found throughout the water column (NMFS, 2006c). The sand tiger shark is uncommon in the Gulf of Mexico and is not likely to occur in the study area (Hoese and Moore, 1998).

The speckled hind (*Epinephelus drummondhayi*) inhabits warm, moderately deep waters from North Carolina to Cuba, including Bermuda, the Bahamas and the Gulf of Mexico. The preferred habitat is hard bottom reefs in depths ranging from 150 to 300 ft, where the temperatures are from 60 to 85°F. The speckled hind was listed as a species of concern 1997 (NMFS, 2006c). This species is rare in the northwestern Gulf of Mexico and is not likely to occur in the study area (Hoese and Moore, 1998).

The Warsaw grouper (*Epinephelus nigritus*) was listed as a species of concern in 1997. It is a very large fish found on the deepwater reefs of the southeastern United States. Warsaw grouper range from North Carolina to the Florida Keys and throughout much of the Caribbean and Gulf of Mexico to the northern coast of South America. The species inhabits deepwater reefs on the continental shelf break in waters 350 to 650 ft deep. As for all of the candidate species above, the main threat to them has been mortality associated with fishing (NMFS, 2006c). Although Warsaw grouper are not likely to occur in the study area, they have been found near jetties and offshore oil platforms (Hoese and Moore, 1998).

FWS and NMFS listed the Gulf sturgeon (*Acipenser oxyrhinchus desotoi*), a subspecies of the Atlantic sturgeon (*A. oxyrhinchus*), as endangered on 30 September 1991 (56 FR 49653 49658). As with other sturgeon species, the damming of rivers has been the most significant threat to the Gulf sturgeon (NMFS, 2006b). Dams are now present on all of the major rivers within the gulf sturgeon's range (Pearl, Mississippi, and Alabama rivers), which prevents upstream migration for spawning. Other threats to the species include over-exploitation, incidental catch, dredging activities, the removal of snags, and dredged material placement associated with channel improvements and maintenance (FWS and Gulf States Marine Fisheries Commission [GSMFC], 1995; NMFS, 2006b).

The Gulf sturgeon is anadromous, which means the species breeds in freshwater environments (i.e., river systems), but spends the remainder of the year in marine and estuarine environments. Spawning occurs in the deeper portions of rivers on clean rock or rubble bottoms. Mud and sand bottoms and seagrass communities are likely important marine habitats (FWS and GSMFC, 1995).

The Gulf sturgeon historically ranged along the northeastern Gulf, in major rivers from the Mississippi delta in Louisiana, east to Charlotte Harbor, Florida and in marine waters of the central and eastern Gulf (FWS and GSMFC, 1995; NMFS, 2006b). Its current range extends from Lake Pontchartrain and the Pearl River in Louisiana and Mississippi east to the Suwannee River in Florida. Sporadic records exist from as far west as the Rio Grande River between Texas and Mexico, and as far east and south as Florida Bay. Viable populations exist in the Mississippi, Pearl, Escambia, Yellow, Choctawhatchee, Appachicola, and Suwannee rivers (NMFS, 2006b).

The NMFS has designated critical habitat for the Gulf sturgeon in Gulf rivers and tributaries (68 FR 13370, 19 March 2003). Although 14 critical habitat units have been identified in Florida, Alabama, Mississippi, and Louisiana, no critical habitat has been designated in Texas and, in fact, none is farther west than Lake Pontchartrain near New Orleans. The study area is not within the known historic range of the Gulf sturgeon. Fish are mobile species and frequently occur outside of their normal ranges, but it is unlikely that the species is present in the study area.

3.16 CULTURAL RESOURCES

3.16.1 Cultural Overview

The project area is located in Brazoria County, Texas which is part of the Southeast Texas Archeological Region of the Eastern Planning Region of Texas (Kenmotsu and Perttula, 1993). The cultural history of the project study area has been assigned to four primary developmental stages: Paleoindian, Archaic, Late Prehistoric, and Historic. These divisions generally are believed to reflect changes in subsistence as reflected by the material remains and settlement patterns of the people occupying this portion of Texas in prehistoric and early historic times.

The earliest generally accepted culture of the Americas, the Paleoindian (10,000–6,500 B.C.) appears to have extended over most if not all, of North America by the end of the Pleistocene epoch. It has been hypothesized that in Texas the Pleistocene coastline extended as much as 25 miles into the present Gulf of Mexico, and that rivers cut deep canyons into sediments deposited during previous periods of glaciation

(Aten, 1983). With the close of the Pleistocene came a period of climatic warming and a consequent rise in sea level as surface water was released from glaciers and polar ice. Paleoindian cultural developments in the Gulf Coastal Plain region, as in most areas of North America, appear to have been intimately related to these gradual but vast changes in the world climate and local environmental conditions.

Occupation of the Texas Gulf Coast during the terminal Pleistocene is evidenced by the recovery of several types of well-made, lanceolate, parallel-flaked projectile points such as Scottsbluff, Clovis, Plainview, Angostura, and possibly San Patrice types. The presence of these distinctive projectile point types along the coastal plain appears to reflect activities that would typically have occurred in areas further inland where the environment is characterized by a mixture of deciduous and pine woodlands (Aten, 1983). According to Aten (1983), this type of habitat typically supports low-density human populations. Archaeological evidence synthesized by Story et al. (1990) from numerous counties comprising the greater Gulf Coastal Plain in Texas, Louisiana, Arkansas and Oklahoma supports the suggestion that the Paleoindian groups probably existed in small nuclear families or bands which migrated widely in pursuit of seasonal subsistence resources.

Cultural developments appear to have progressed somewhat beyond those of the Paleoindian period with the onset of the Holocene epoch. Changes in the world climate caused sea levels to rise, inland prairies to expand and regional weather patterns to become more variable (Aten, 1983). Generally, termed the Archaic (7,000 B.C.–A.D. 700) this next period of cultural development in the New World has been further sub-divided into Early, Middle, and Late stages based on changes observed in the archaeological record that appear to coincide with episodic shifts in the Holocene climate and environment. It is commonly thought that human lifestyles and subsistence strategies maintained patterns developed during the previous Paleoindian period, but with some notable differences.

Aten (1983) suggests that Early Archaic groups, like their Paleoindian predecessors, probably continued to migrate seasonally in small bands and relied on a generalized projectile point technology to facilitate their hunting and gathering of a variety of faunal and vegetal foodstuffs. Despite a paucity of intact Archaic components at sites in the upper Texas Gulf Coast region, it has been observed that Archaic lithic technologies appear to show an increased diversity of functional types and styles over those associated with the Paleoindian period. However, the level of craftsmanship and the use of fine exotic materials appear to have declined. In addition, the greater array of Archaic projectile point styles appears to reflect a greater degree of regional cultures. Story et al. (1990) surmise that Archaic period human populations may have become more dense with individual bands covering less overall territory on their seasonal rounds.

Differentiation between Early, Middle, and Late Archaic culture sites in the upper Texas Gulf Coastal region, without the benefit of sufficient associated cultural features and artifacts from which strong chronological dates and sequences can be derived, has been based largely on observation and comparison of projectile point styles associated with more intact archaeological contexts elsewhere in Texas and North America. The assumption has been that similar point styles are probably related chronologically despite sometimes, vast geographical distances. According to these lines of reasoning, Early Archaic point types are usually considered to include Baird, Bell, Andice, and Wells, whereas Bulverde, Carrollton, and Trinity points are usually attributed to the Middle Archaic stage. Based on a relatively greater database for defining the Late Archaic, point types considered diagnostic of this cultural stage typically include Gary, Kent, Yarbrough, Ellis, Palmillas, and Refugio (Patterson, 1979).

The Late Pre-Ceramic, which coincides, in part, with Late Archaic elsewhere in Texas, extends from the approximate period in which the sea level attained its present state until the advent of ceramic service and storage vessels, ca. A.D. 100 (Aten, 1983). During this period, population increased significantly, marked by an increase in the number of sites as well as intra-site artifact frequencies (Aten, 1983). Hall (1981) has also noted an increase in traumatic death and the development of trade relations with Woodland cultures to the east during the Late Archaic. A settlement system, which may have included a seasonal round with group dispersal in coastal areas during the summer and consolidation in inland areas during the winter months, may have begun during the Late Archaic (Aten, 1983). However, the occurrence of shell middens at Late Archaic sites is not as common as at later sites (Patterson, 1979). Projectile points diagnostic of Late Archaic occupations include Gary, Kent, Yarbrough, Ellis, Palmillas, and Refugio (Patterson, 1979).

The Late Prehistoric, or Ceramic period (700–1519 A.D.) cultures experienced a relatively static environment. This stage lasted from the time when ceramics were adopted until European interaction with the aboriginal populations became firmly established.

The addition of Perdiz and Scallorn arrow points to the inventory marks the beginning of the Late Ceramic period. Ceramics of the earlier period may include Goose Creek Plain, variety Anahuac, O'Neal Plain variety Conway, Mandeville Plain, Tchefuncte Plain, Goose Creek variety unspecified, and Tchefuncte Stamped. In the Late Ceramic period, the ceramic inventory may include San Jacinto Incised and Baytown Plain varieties Phoenix Lake and San Jacinto (Aten, 1983). It should be noted, however, that several varieties of Goose Creek Plain, as well as Goose Creek Incised (and Red-Filmed), and the occurrence of bone tempering, span much of the Ceramic period.

Population during the Late Prehistoric tended to increase until European-introduced disease helped to decimate the aboriginal inhabitants. Patterson (1979) observed an increase in numbers of Late Prehistoric sites, while individual sites exhibit fewer cultural remains. He interprets this as evidence of a more mobile lifestyle.

3.16.2 Native Inhabitants

When Europeans arrived on the northern Texas coast, they encountered two major native groups, the Atakapa and the Karankawa Indians, who occupied separate territories divided approximately at the western shore of Galveston Bay. The Atakapan, speaking a language of the Tunican family, displayed traits closely related to the natives of southwestern Louisiana. The Karankawan groups spoke a language of the Coahuiltecan family and were more closely related to the Indians further south in Texas and Mexico.

In spite of differences in language and apparent cultural derivation the Atakapa and Karankawa maintained similar cultural patterns (Ricklis, 1996). Both groups were nomadic, although the Atakapa maintained semi-permanent winter villages in the interior. The Atakapa subsisted on shellfish, fish, birds' eggs, wild plants, deer and bear while the Karankawa ate shellfish, turtles, marine and land plants, alligator, deer, bison, bear, and peccary. Conical huts and skin tents served as shelter for the Atakapa while the Karankawa lived in portable windbreak style huts. Atakapan technology included pottery, bows and arrows, dugout canoes, basketry, traps, manos and metates, drums and flutes, wooden bowls and utensils, and grass fiber textiles. The Karankawa also used pottery, basketry, cane weirs, milling stones, drums and whistles, tambourines, lances, clubs, axes, bone tools, and bow and arrows along with dugout canoes propelled by poles. Both groups buried their dead in burial mounds and left refuse middens, primarily shell. Both wore breechcloths and skirts and decorated themselves with tattoos. Both groups were equally unprepared to defend themselves and their cultural traditions from the newly arrived Europeans. By the late eighteenth century, both the Atakapa and Karankawa peoples were in serious decline (Ricklis, 1996).

3.16.3 European Exploration and Colonization

European exploration of the Texas coast began, albeit by accident, in November 1528. Álvar Núñez Cabeza de Vaca was a member of the Narváez expedition that was destined for Pánuco (Tampico), Mexico. Cabeza de Vaca and his men were plagued with misfortune when the expedition departed from Florida in April (Creighton, 1975). While adrift and seeking fresh water, de Vaca's group discovered the mouth of the Brazos River, naming it Los Brazos de Dios, the Arms of God.

French exploration of Texas in the seventeenth century was focused primarily in the Matagorda Bay area. René Robert Cavelier, Sieur de La Salle traversed the Brazos River in 1686, though his journey did not take him to the river's mouth. An unfortunate malady that occurred at this time inspired La Salle to name the river the Rivière Maligne. While crossing the river on a raft, La Salle's servant Dumesnil was pulled into the water by an alligator and killed (Weddle, 1991).

The Spanish conducted preliminary exploration and mapping of the Freeport area in the early eighteenth century. In 1724 Brigadier Pedro de Rivera y Villalón began a three-year-long inspection tour of the 23 military outposts in northern New Spain (Chipman 1992; Weddle 1991). A series of six maps of northern New Spain created by Francisco Alvarez Barriero during the expedition is considered the first attempt at a systematic mapping of Texas (Weddle, 1991). Following this study, the Texas governor was required to conduct an annual surveillance of the coast from Matagorda Bay to the Sabine River (Weddle, 1991).

Captain Carlos Luis Cazorla conducted a survey in 1772 to identify the level of trade between the local tribes and newly established English trading posts. On his return trip he traveled down the Brazos to its entry into the Gulf, near present-day Freeport. He discovered that the stream divided into two channels with a maze of lagoons. This was the first exploration of the mouth of the Brazos (Weddle, 1992). Ineffectual organization and motivation prevented additional substantial exploration of the Texas coast east of Matagorda Bay. It would not be until the early nineteenth century that successful immigration to the Brazos would be realized.

3.16.4 Early Settlements (1800–1835)

In 1821 the governor of Texas, Antonio Martínez, granted permission to Moses Austin for the creation of Mexican colonies in Texas. After Moses' death later that year his son, Stephen F. Austin, selected the lands for colonization. Austin organized a group of 18 immigrants that landed at the mouth of the Brazos River in late December 1821 (Bugbee, 1899). Though they mistakenly landed at the Brazos River instead of the intended destination of the Colorado River, the group labored for several weeks exploring the immediate area and building seven boats for carrying their supplies upriver. In February, the party journeyed up the Brazos until the first "high land" was sighted. At this site (Velasco), a large log house was erected and preparations were made for planting a corn crop (Bugbee, 1899). Asa Mitchell arrived at the mouth of the Brazos in January 1822 and opened a salt-manufacturing business (Creighton, 1975). He received the title to this land in 1824 and lived in the Velasco area until moving to Washington-on-the-Brazos in 1835, thus becoming possibly the first colonist to settle permanently at the site (Earls et al., 1996).

The advantageous location of Mitchell's land grant, at the juncture of the Brazos River and the Gulf of Mexico, persuaded Austin in 1823 to propose the location as a port. Austin acknowledged, in December of 1835, that Velasco was without a natural harbor and also had a treacherous sand bar at the mouth of the river (Earls et al., 1996). Despite these drawbacks, entrepreneurs encouraged steamboat navigation on the Brazos to cater to the cotton plantations along the river. The establishment of a trading post at Bell's Landing (now East Columbia) by John Richardson Harris in the 1820s encouraged the use of the river for the trade and transportation of commodities. Harris's small schooner, The Rights of Man, may have been the first vessel specially designated for trade between the Brazos River, Galveston Bay, and New Orleans (Earls et al., 1996). The popularity of Velasco as a commercial trade center was superceded by Brazoria, 15 miles upriver, which had been established about five years earlier. In 1833, Mitchell formed a land association with his neighbors William H. Wharton and Branch T. Archer. This collaboration would develop Mitchell's property into a thriving river and seaport (Earls et al., 1996).

Increased immigration into Texas in the 1820s possibly encouraged Mexico to create several military outposts, one of which was established at Velasco in 1831 (Rowe, 1903). Asa Mitchell was commissioned to serve as a boarding officer at Velasco by the fall of that year (Earls et al., 1996). With the establishment of the fort and customshouse at Velasco, the Mexican government attempted to forcibly regulate Brazos River traffic and exert tax and customs control. The conflicts created by these new restrictions culminated at Velasco in 1832. In response to friction between Mexican authority and the colonists, 150 men gathered to attack General Ugartechea at Velasco. The Mexican force commanded by Ugartechea was composed of 91 men. On June 26, three divisions of colonists attacked the fort until sunrise the following morning (Rowe, 1903). The fort's cannon fired upon the town's structures, destroying all but the customshouse and a small office (Smith, 1910). Surrender was negotiated on June 29th, in which Ugartechea's troops were ordered to withdraw (Rowe, 1903).

Following the battle, Mitchell began to sell portions of his property, possibly to facilitate town rebuilding. In addition to the public sale of lots, the Velasco Association also announced construction of a major hotel to accommodate its many anticipated visitors (Earls et al., 1996). A nationwide cholera epidemic finally touched Velasco in the spring of 1833; only 12 of the 20 townspeople survived (Earls et al., 1996). This tragedy, and a diversion of town resources towards Texas's quest for independence, would quell the building initiative envisioned by the Velasco Association. Their grand designs would not again be revisited until after the conclusion of the Texas Revolution in 1836 (Earls et al., 1996).

3.16.5 Texas War for Independence (1835–1836)

Though Velasco was not a location of direct military engagements after 1832, it was used as a training post for Texas militia. John Sowers Brooks began drilling 250 men in late December 1835 (Roller, 1906). Anticipating a military conflict with Mexico, the abandoned fort at Velasco was refortified with a long 18-pound cannon and several smaller artillery pieces (Earls et al., 1996). Though humble in appearance, the fort was described as the best coastal defense work in Texas in May of 1836 (Pierce, 1969).

Velasco itself did not witness growth during the years of conflict (Earls et al., 1996); however, its location at the mouth of the Brazos River was strategically important to the movement of troops and supplies throughout Texas. The region experienced a marked increase in maritime activity during the Texas Revolution. Quintana, Velasco's competitor on the river's east bank, was also the location for the mercantile house of Thomas McKinney and Samuel Williams. This commercial house is accredited with establishing the first regular steam commerce on the Brazos and served plantation owners such as William Wharton (Puryear and Winfield, 1976). It was also instrumental in providing funds and military supplies for the Texas cause (Miller, 2004). Military supplies for the Texas volunteers were stored in warehouses in Velasco and Quintana (Miller, 2004). Vessels transported supplies and volunteers from New York and New Orleans to both Quintana and Velasco (Brinkley, 1937). These materials were then transshipped to locations such as Galveston, Matagorda, Columbia, and Copano Bay (Brinkley, 1936).

Velasco was homeport to the vessels Invincible, Yellow Stone, and Independence. The schooners Invincible and Independence were both purchased as vessels of the 'privateer' Texas navy organized in 1836 (Barker, 1927; General Council, 1839). The steamboat Yellow Stone was used by Sam Houston to transport troops and supplies across the Brazos River in April 1836 (Hardin, 1992).

The surrender of the Mexican army at San Jacinto was negotiated in the Treaty of Velasco, signed at Velasco on May 14, 1836, by Antonio López de Santa Anna and David G. Burnet, ad interim president of Texas. Santa Anna was forced to stay on the schooner Invincible when Texas troops under Thomas Jefferson Green refused to allow his departure to Veracruz. Santa Anna spent the next several months as a prisoner at Velasco until he was moved to Columbia towards the end of the year (Miller, 2004).

3.16.6 Texas Republic (1836–1845) and Early Statehood (1845–1862)

Following the battle of San Jacinto, ad interim president David G. Burnet selected Velasco as the location for his government offices (Winkler, 1906). Velasco was never able to earn the distinction of being Texas's "first capital," as the seat of government was transferred to Columbia in October 1836 (Pierce, 1969). Brazoria County was subsequently created on December 20, 1836. Velasco, Columbia, and Brazoria were incorporated in June 1837. These first few years of the Texas Republic, from 1836 to 1840, was the greatest period of development for Velasco (Earls et al., 1996).

At the close of the war, and with the resumption of port and customs activities, Velasco received renewed commercial interest. The Velasco Association reorganized and expanded its membership to include such key individuals as Jeremiah Brown and Isaac Hoskins (Earls et al., 1996). The year 1837 was both the height of land sales/building activity in Velasco and the beginning of a boom in port activity. An average of 425 persons arrived annually at Velasco in 1837, 1838, and 1839 (Earls et al., 1996). Velasco additionally had an average of 36 vessels visiting its port annually during the Republic years. The largest number of vessels to anchor at Velasco was 85 in 1838 (Earls et al., 1996).

Velasco's growth and importance as a commercial entity declined with the emergence of Galveston as one of Texas's principal ports. An analysis of commercial activity in 1839 demonstrated that even with Galveston's more-abundant maritime traffic, its export value was nearly matched by Velasco (Earls et al., 1996). Additionally, delayed effects of an economic depression in 1837 would impact the value of property lots, causing them to crash near the end of 1839 (Earls et al., 1996). The economic crash and the effects of reoccurring storms would quash Velasco's continued growth and development as a commercial center.

In an attempt to sustain Velasco's role in trade, a steam vessel, Lafitte, was built in 1840 to run on the Brazos between Velasco, Galveston, and the Sabine River (Earls et al., 1996). The use of the Lafitte for Brazos River shipping was fleeting. In 1842, with renewed hostilities with Mexico, the Lafitte was pressed into Texas government service as she lay at anchor in Galveston Bay (Haviland, 1852). In this same year, Sam Houston spent $9,000–10,000 fortifying the 370-mile Texas coastline at three places: Galveston, Velasco, and Matagorda (Wells, 1960). The effort to reinforce and protect Texas's coast, however, did not prevent the economic demise of Velasco.

The decline in shipping at Velasco, combined with the associated hazards of its riverine access, initiated the overland transportation of goods in this area. In the waning years of the Republic period, Velasco continued to depreciate in both real estate and shipping. A major tropical storm in 1842 dropped Velasco's sea trade to only five vessels in that year (Earls et al., 1996). By the mid-1840s Velasco had digressed from its reputation as "coming city of the Gulf" to a seaside resort and mail stop (Earls et al., 1996).

In spite of the difficulties at Velasco, the Brazos area prospered in cotton and sugar. Planters transported their goods overland and shipped them from Galveston. In the 1850s a proposed intracoastal waterway between Velasco and Galveston promised to bring more commercial activity to the mouth of the Brazos. With completion of the canal in 1856, sternwheel steamers transported cargoes from Galveston up the Brazos River (Dorchester, 1936). Rather than revitalize maritime commerce in this area, the waterway circumvented trade from Velasco to Galveston (Dorchester, 1936). Planters continued to ship goods down the waterway to Galveston, which as a consequence bolstered the city's now undeniable reputation as a maritime trade center.

3.16.7 American Civil War (1861–1865)

In antebellum Texas, in the region of Houston and Galveston, the farming of cotton and sugarcane was highly profitable (Buenger, 1984). Planters along the Brazos River were increasingly dependent on slave labor. In 1860, 18 of the state's 44 slaveholders resided in Brazoria, Wharton, and Fort Bend Counties (Buenger, 1984). Many of the planters who lived in this region were very wealthy; one-fifth of all Texans with estates valued at over $100,000 were from these three counties. These slaveholders collectively owned more than 100 slaves (Buenger, 1984). The dependence on slave labor created unyielding support for secession, and an overwhelming majority of residents voted in favor of withdrawal from the Union on February 23, 1861 (Buenger, 1984).

Texas itself became important as a source of military supplies for the Trans-Mississippi region of the Confederacy (Barr, 1961). Federal gunboats patrolled the Texas coastline in an effort to blockade strategic waterways such as Galveston Bay and the Sabine River. Forts were erected at Quintana and Velasco (Looscan, 1898). At the outbreak of the Civil War there were only four Federal blockaders operating off the Texas coast (Barr, 1961). In January 1862, the ships Midnight, Arthur, and Rachel Seaman shelled the coastal fortifications at both Aransas Pass and Velasco (Barr, 1961). The fort at Velasco fired upon the vessels with such accuracy that the captain of the Midnight thought the fort was defended by heavy (possibly rifled) guns. The fort had only a single piece of artillery, an 18-pounder (Creighton, 1975).

Following Confederate victories at Galveston and Sabine Pass in 1863 and with Union possession of the southern half of Texas's coast, Confederate forces concentrated on holding Sabine Pass, Galveston, and Velasco at all costs. Velasco itself was so heavily reinforced, with a battery of six 32-pounders, that Federal blockaders never engaged the fort for any great length of time (Barr, 1961). By late 1864 the number of cannon at Velasco had increased to 8, with Galveston having a total of 41 cannons. Blockade-running in Texas had grown to such an extent that by 1865 the blockade squadron off the Texas coast had no fewer than 20 ships (Barr, 1961).

3.16.8 Post-Civil War and Early Industrial Revolution (1865–1910)

With the close of the Civil War and the abolition of slavery, the commercial viability of Velasco and Quintana became greatly depressed. At the end of the nineteenth century Velasco had only a general store and boat-builder's shop. Only 2 of the 20 plantations in Brazoria County were still held by their prewar owners, the rest having been sold or lost to taxes (Earls et al., 1996).

Storms in the late 1860s and early 1870s forced many families to move inland or leave the area altogether. The remaining Velasco lands were sold in 1872 and transferred to the Texas Land Company. With the acquisition of these properties, Velasco ceased to be a municipal entity. The great storm of 1886 and the hurricane that followed in 1887 destroyed any remaining town structures (Earls et al., 1996).

At the urging of W. M. D. Lee, Velasco was redeveloped in order to facilitate the building of a deep-water port at the mouth of the Brazos River. Lee was a Texas cattle baron and oilman. He believed a deep-water port at the mouth of the Brazos was the best way to move his cattle to market (Earls et al., 1996). In February 1888, Lee filed his charter for the Brazos River Channel and Dock Company. When construction began in April 1889, the influx of workers increased the population of Velasco from 50 residents to 700 by the end of the year (Earls et al., 1996). A new location for Velasco was surveyed and laid out in 1891, with the old site becoming the town of Surfside. Surfside was platted as a resort town, and a large beachfront hotel was built to help raise funds for the construction project (Earls et al., 1996). The Galveston hurricane of 1900 destroyed much of the Brazoria County coastline, including the hotel. A second hotel, built on its original site, was destroyed by fire in 1904 (Earls et al., 1996). These successive events destroyed any remaining impetus for the development of commercial enterprise at this location until the founding of Freeport in 1912.

The city of Freeport, Texas, was founded on November 20, 1912, on the west bank of the Brazos River and adjacent to the historic site of Velasco (Freeport Townsite Company, 1912). The Brazos River itself was strategically important for the transportation of needed goods and supplies inland. The importance of this riverine passage to mercantile trade preempted the founding of Freeport, as well as Velasco and historic Quintana.

3.16.9 File and Literature Review

A site file and records review was conducted for the Port Freeport Ship Channel Widening project in Brazoria County. The files at the Texas Archeological Research Laboratory (TARL) and at the Texas Historical Commission (THC) were both examined for the location of recorded terrestrial archaeological sites, listed National Register of Historic Places (NRHP) properties, State Archeological Landmark (SAL) sites, and Texas Historic Markers (THM). The ship wreck files at the THC's State Marine Archeologist Office were also examined for the location of plotted shipwrecks. The results of the file and literature review are presented in the following section.

3.16.10 Previous Investigations

Several previous terrestrial and nautical archaeological investigations have been completed in the area near Freeport, Texas. Those reports that are pertinent to the current project include terrestrial surveys and data recovery, marine magnetometer surveys and diver investigations, and archival research.

Since the 1970s, professional and avocational archaeologists have conducted investigations into the old Velasco (41BO125) and Quintana (41BO135) townsites in southern Brazoria County, Texas, on either side of the original mouth of the Brazos River. In 1975, Ippolito and Baxter (1976), working for the Texas A&M Research Foundation, conducted an intensive archaeological survey of an area between the Brazos River Diversion Channel and the Freeport Harbor navigation channel for the USACE. One prehistoric site (41BO117) and three historic sites (41BO116, 41BO123, and 41BO125) were recorded. Excavations at site 41BO125, on the east bank of the Old Brazos River channel, revealed a large portion of a circular brick foundation and some smaller rectangular foundations which Ippolito and Baxter (1976) attributed to Fort Velasco. However, additional field work and historic research conducted in 1980 by the Center for Archaeological Research (CAR), at the University of Texas at San Antonio, indicated that these brick foundations were not part of the original Fort Velasco (Fox et al., 1981). CAR's work placed the general site of Fort Velasco within Monument Square, between the USCG Station and Surfside City Hall (Fox et al., 1981).

Since 1981, the Brazosport Archaeological Society has been acquiring surface collections from the old Velasco townsite for the Brazosport Museum of Science (Earls et al., 1996). During the latter part of 1992 and early 1993, Prewitt and Associates, Inc., conducted site testing and data recovery at the old Velasco townsite (41BO125) for the USACE (Earls et al., 1996). Over 400 features were documented, ranging from postholes to structures. The majority of a large artifact assemblage recovered from the site supports an 1830–1840s habitation date. The final report on this work contributes greatly to knowledge of the early habitation period in this area.

The USACE conducted a study in 1975 to identify historical and archaeological sites within Freeport Harbor (USACE, 1975). They found two sites of historical interest, including the Quintana Cemetery, which dates to 1822 and is located on Quintana Point, on the southern side of the mouth of the Brazos; and the site of the battle of Velasco in 1832, located near present-day Surfside. Neither of these sites was considered to be in danger of being affected by maintenance to the navigation channel. They also found no previously recorded archaeological sites in the project area (USACE, 1975).

Following the USACE's 1975 report, a survey to locate magnetic anomalies in Freeport Harbor was conducted. Offshore investigations of the area were initially reconnoitered by Odom Offshore Surveys, Inc. in 1978 (Odom, 1978) and completed by Fairfield Industries in 1979 (Fairfield, 1978). Based on the magnetic data Odom and Fairfield collected, the NPS conducted a two-day submerged cultural resources assessment, which revealed the wreck of a modern vessel north of the jetties (Murphy and Lenihan, 1980). Following this initial submerged investigation, the Texas A&M Cultural Resources Laboratory conducted additional submerged cultural resources evaluations, investigating six magnetic anomaly clusters, which revealed only modern cultural debris (Bond, 1980). An additional underwater investigation of five anomaly clusters was completed by the Archaeology Program of the Institute of Applied Sciences, North Texas State University and Texas A&M University's (TAMU) Department of Nautical Archaeology in 1981. The resulting report (Hays, 1981) indicates that none of the anomaly clusters represented sites of potential cultural significance.

In the mid-1980s, Espey, Huston & Associates, Inc. (EH&A, now PBS&J) conducted a cultural resources records search for potentially significant offshore resources adjacent to Freeport, Texas. This study was conducted under contract with the USACE to locate any previously documented cultural resources potentially impacted by the designation of a proposed site for the disposal of material associated with the construction and maintenance of the Freeport Harbor and Jetty Channels. They searched the records held by the Texas Antiquities Committee (now the THC), finding 22 historically significant sites near the proposed disposal area (EH&A, 1987). According to the EH&A (1987) EIS, the areas near the historically significant sites were excluded from the potential selection area for the ODMDS.

During the construction of a rock jetty, as part of the Freeport Harbor Project, the remains of a shipwreck were discovered. This shipwreck was initially investigated by Floyd in August 1988, and again more extensively later that same year. The wreck was identified as the General C.B. Comstock, and was documented and removed in order for the construction of the jetty to be complete (James et al., 1991).

Between 1996 and 1997 EH&A conducted a reconnaissance-level archival study to locate sites of potential historical significance along the GIWW between High Island, Texas, and the Brazos River Floodgate. They identified 194 properties of potential significance, 50 of which are within the vicinity of the current project area. These properties range from graveyards to historic buildings, forts, bridges, and shipwrecks (Hoyt et al., 1999).

Also in 1999 PBS&J evaluated historical sites, both terrestrial and nautical, in relation to proposed channel modifications along the GIWW (Hoyt et al., 1999). Thirteen shipwrecks were identified in the report, lying between Oyster Creek and the Brazos River. Eight of these shipwrecks are located in or near the survey area. The locations for all the shipwrecks in this study were drawn from historical and archival sources.

3.17 LAND USE/RECREATION/AESTHETICS

3.17.1 Land Use

Brazoria County lies in the Coastal Bend region of Texas. Land use within the area consists of agricultural land, industrial land, urban-residential and urban-commercial land, recreational land and facilities, and marshlands. Water use includes mineral production, commercial and sport fishing, recreation, and transportation.

In Brazoria County, agriculture has historically been, and continues to be, an important part of the economy. Approximately 61% of the land is used for agriculture, with 41% used for range and pastureland and the remaining 20% cultivated (NRCS, 2000). Within Brazoria County, only about 14% of land use is considered urban. According to the U.S. Department of Agriculture (USDA) 2002 Census of Agriculture, Brazoria County had 2,455 farms in 2002, up 8% from 1997, and had approximately 614,000 acres of land in farms. In 2002, the market value of production for Brazoria County was

$47,422,000 with crop sales accounting for 52% and livestock sales accounting for the remaining 48% (USDA, 2002).

The study area (Brazoria County) encompasses Freeport Harbor Channel, the GIWW to the north, Surfside Beach to the east (including Jetty Park and public beaches), open lands (including extensive nonforested wetlands) to the northwest, wetlands and open lands to the southwest, and the Village of Quintana, which includes a scattering of residential properties, Quintana Beach County Park, bird sanctuaries and open lands to the south and east on Quintana Island. Along the southeastern portion of the study area is the Gulf of Mexico (Figure 3.17-1).

The Port of Freeport is located northwest of Quintana and Surfside Beach and currently comprises 186 acres of developed land and 7,723 acres of undeveloped land (Port Freeport, 2006). There are various facilities along the channel including the Exxon Quintana Station and PF&T Quintana Terminal to the west, and Dow Chemical Plant to the north. All parcels are accessible by water, highway and rail.

Included in the project area are residences, parks, civic buildings, and other businesses such as restaurants and night clubs. To the south of the GIWW (which parallels the Gulf of Mexico), land uses consist primarily of single-family homes, condos, and a few businesses. The Quintana Beach Park is located southwest of the channel with access to the Gulf of Mexico. A USCG station is located along the channel in the northeast portion of the project area.

3.17.2 Transportation

There is direct access to the GIWW and the Freeport Harbor utilizing FM 523, State Highway (SH) 36, SH 288, and SH 332 with rail service provided by the Union Pacific Railroad (UPRR). Surface transportation in the vicinity of Freeport is provided by a network of primary, secondary, and local roads. SH 288 is the primary land route connecting the Freeport area with the Houston metropolitan area, approximately 50 miles to the north. Primary access to the Village of Quintana from Freeport is via SH 288 and FM 523 from Oyster Creek to the northeast. Once across the GIWW, service to the Village of Quintana is provided by various local streets including Quintana Road and 2nd Street with access to the Freeport Harbor Channel. Access to Surfside Beach from Freeport is via SH 332 and FM 523 from Oyster Creek to the north. Once across the GIWW, service to Surfside Beach is provided by various local streets, including Fort Velasco Drive and Parkview Road, which provide access to the channel.

Rail transportation is integral to the operations of Port Freeport and numerous industrial sites located along the Freeport Harbor Channel. The UPRR provides direct service to facilities located along Brazos Harbor. There are approximately 50,000 railcar transits per year at Port Freeport (Port Freeport, 2006).

3.17.3 Community Services

Brazoria County has a well developed infrastructure to provide health, police, fire, emergency, and social services within the study area. A wide range of public services and facilities are offered at different

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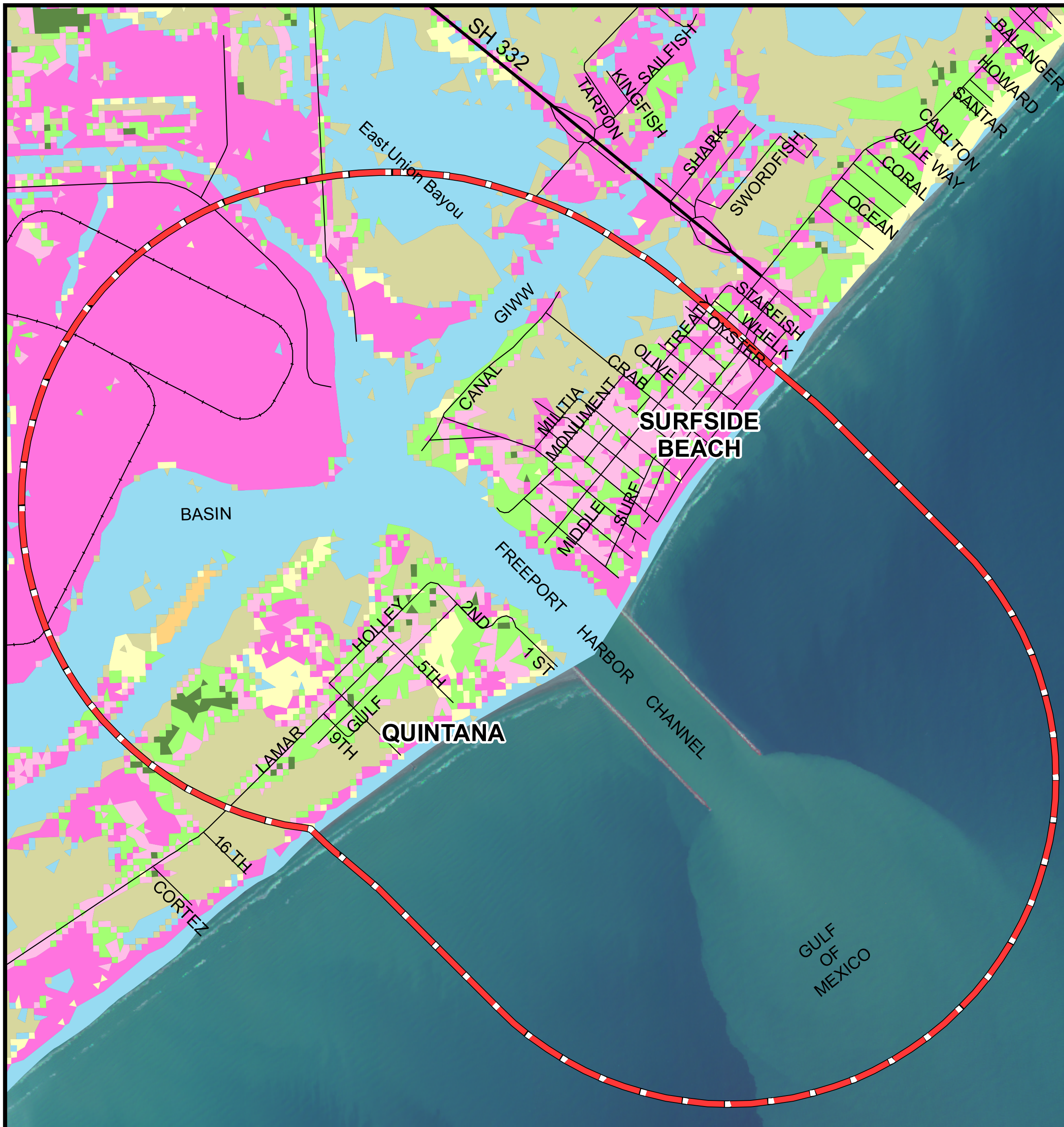

PBSJ
6504 Bridge Point Pkwy, Ste. 200
Austin, Texas 78730
Phone: (512) 329-8342 Fax: (512) 327-2453

Figure 3.17-1
Land Use - Freeport Channel

Prepared for: Tricia LaRue

Job No.: 441591.00 | Scale: 1:30,000

Prepared by: EMons/APugh | Date: 08/30/2006

File: N:/44159100/Projects/3_17_1_LandUse.mxd

Legend

- Land Use Study Area
- Agricultural
- Bare or Transitional
- Grassland
- High Intensity Developed
- Low Intensity Developed
- Non-Woody Wetland
- Open Water
- Woody Land
- Woody Wetland

N, E, S, W

2,500 1,250 0 2,500

Feet

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locations from the local communities of Surfside Beach, the City of Freeport, Quintana Beach, and the Lake Jackson/Clute area. The regional provider of hospital and healthcare services is the Brazosport Memorial Hospital. Professional services are found in the larger communities of Freeport and Lake Jackson. All areas of the county are served by the Brazoria County Sheriff's Department and the Texas Department of Safety. Individual communities are served by police or marshals. All departments have regular 24-hour patrols.

Fire protection within the study area is provided by the Freeport Fire Department. The Freeport Fire Department is a "Combination Department" in that it has ten full-time employees and 19 reserve members (Stanford, 2006). The assigned service area for fire protection includes the Village of Quintana, by an annual contract, and coverage for Surfside Beach. The service area includes approximately 175 square miles, of which 20 square miles is located within the city limits of the City of Freeport. The department operates out of two stations with one station on each side of the city and an additional station utilized primarily for storage of excess equipment. The department has three class "A" pumpers; two command vehicles; one beach rescue vehicle; one water tanker truck; one crew cab flat-bed utility truck; one 5-ton crew cab utility truck with one 36-ft enclosed fifth wheel trailer, which contains a high-pressure breathing air system and hazardous material equipment; three ambulance units; one 55-ft snorkel elevated water fire truck; two fire boats, with an additional class "A" pumper, and an ambulance to be added in 2006.

The Freeport Fire & Emergency Medical Service (EMS) Department currently provides EMS service to City of Freeport, Village of Quintana, and Surfside Beach. In 2006, Surfside Beach will provide emergency services through the Surfside Beach Police Department with one full-time employee, one part-time employee and volunteers (*The Alliance*, 2006a). Surfside will be capable of providing their own EMS; however, the Freeport Fire & EMS Department will continue to provide backup for Surfside Beach (Stanford, 2006).

Law enforcement within the study area is served by both state and local departments. The Texas Highway Patrol, a service of the Texas Department of Public Safety's Traffic Law Enforcement Division, maintains an office in Angleton. The Brazoria County Sheriff's office and the Texas Highway Patrol serve the highways in unincorporated areas of Brazoria County. Within the incorporated area of Brazoria County, the cities of Freeport, Quintana, Oyster Creek, and Surfside Beach all provide police protection.

The Brazosport Independent School District has schools within the communities of Freeport, Oyster Creek, Quintana, and Surfside Beach. The District includes 19 campuses, encompassing 11 elementary schools, 2 middle schools, 3 intermediate schools, 2 high schools, and an alternative placement center (Brazosport ISD, 2006). Higher education is available through the Brazosport College campus located in Lake Jackson. It is convenient to all towns and cities in South Brazoria County and offers a broad range of courses and classes to address diverse educational goals. Students planning to pursue a bachelor's degree can enroll in introductory academic classes, as well as courses in sixteen majors, which transfer to four-year schools (Brazosport College, 2006).

Within Brazoria County, a variety of entities provide electric utility, natural gas, water, wastewater, and solid waste disposal services. These services are summarized in Table 3.17-1.

TABLE 3.17-1

PUBLIC SERVICES AND UTILITIES FOR STUDY AREA, 2005

	Electric Utility Service	Natural Gas Service	Water	Wastewater	Solid Waste Disposal Service
City of Freeport	Reliant	Center Point Energy	City of Freeport	City of Freeport	City of Freeport
Village of Quintana	Reliant	Center Point Energy	Village of Quintana	Individual Septic System	IESI Solid Waste Management
Surfside Beach	TXU	none	Surfside Beach	Surfside Beach	Surfside Beach
Oyster Creek	TXU	none	Oyster Creek	Oyster Creek	Oyster Creek

Source: City of Freeport, 2006; Reliant Energy, 2006; Center Point Energy, 2006; IESI, 2006.

3.17.4 Aesthetics

The term aesthetics deals with the subjective perception of natural beauty in a landscape by attempting to define and measure an area's scenic qualities. Consideration of the visual environment includes a determination of aesthetic values (where the major potential effect of a project on the resource is considered visual) and recreational values (where the location of a proposed project could potentially affect the scenic enjoyment of the area). Aesthetic values considered in this study, which combine to give an area its aesthetic identity, include:

- topographical variation (hills, valleys, etc.)
- prominence of water in the landscape (rivers, lakes, etc.)
- vegetation variety (woodlands, meadows, etc.)
- diversity of scenic elements
- degree of human development or alteration
- overall uniqueness of the scenic environment compared to the larger region

The study area consists of a variety of terrain characterized by varying levels of aesthetic quality. The topography of the area is mostly flat to gently rolling, with very few outstanding elevational changes. However, the study area consists mostly of open-water areas. Landscapes with water as a major element are generally considered visually pleasing, and this is the case for recreational land adjacent to these water features. However, the study area has also seen widespread urban development which can detract or add, depending on the type and scale, to the overall aesthetic quality. The study area includes a variety of land uses, including shoreline residential development, commercial development, public and private marinas, parkland, relatively undisturbed natural areas, fishing and tourism related businesses, civic uses, transportation systems (highways and railways), port facilities, and heavy industry areas.

Generally, these areas are considered to be visually pleasing, with the exception of industrial and port facilities located along the Freeport Harbor. However, generally speaking, the area is distinguished in aesthetic quality from other adjacent areas within the region that lack the vast water bodies of the study area and many of the outdoor recreational amenities. The landscape exhibits a generally moderate to high level of impact from human activities. No designated scenic views or scenic roadways were identified from the literature review or from field reconnaissance of the study area.

3.17.5 Future Development and Development Restrictions

There are approximately 8,000 acres of land adjacent to the Gulf of Mexico available for future development of the Port of Freeport. Future expansion of the Port of Freeport includes a LNG facility (under construction), construction of new berths, and the building of a transit shed. A significant development known to the BRHND is the construction of a $750 million facility to receive and store LNG, convert the product back to a gas and transport it to commercial and industrial users via pipeline. The project is expected to be completed in three years and is expected to generate increased funding for the Port and provide facilities for the local petrochemical industry. The District also plans to construct three 1,200 ft berths; which would begin with the construction of one 800-ft section in 2006. In addition, the District has begun engineering design for Transit Shed 6 adjacent to Dock 5. The 125,000-square ft facility would include rail service and may attract new business to the Port (Port Freeport, 2006).

Throughout Brazoria County, future projects include expansion of highways, new schools, new businesses, and improvements to water and sewer projects in communities such as Surfside Beach. Big industrial employers, including Freeport LNG, BASF, Dow Chemical, and Conoco Phillips will expand with major projects. Freeport will become BASF's Corporation's manufacturing base for nylon intermediates and polymers in North America with a new plant to be constructed on-site in 2007 (*The Alliance*, 2005a). Food companies such as GrupoSOS will begin construction of the first phase of their $200 million expansion (*The Alliance*, 2006b).

Future development in Surfside includes a proposed 9-acre, 400-slip, dry dock marina that would be located off of SH 332. The marina would cater to the sport fishing and yacht community and would include a restaurant, retail shops, showers, and a laundry facility. In addition, the Surfside marina would have 17-ft deep water and two helipads (*The Alliance*, 2006c). In addition to the proposed marina in Surfside, Freeport has plans for a marina to be built on the Old Brazos River which would potentially attract restaurants and hotels around the site.

Enhancements to highway and rail capabilities in the area will include widening SH 36 from two lanes to four lanes to facilitate hurricane evacuations, passenger, and freight movement. There will also be improvements made to SH 288, the main direct north-south route between Freeport and Houston. Enhancements to rail capabilities will include replacement of a rail bridge over the old Brazos River channel in downtown Freeport to serve increasing cargo volumes from Port Freeport (*The Alliance*, 2006d).

3.18 SOCIOECONOMIC RESOURCES

This section presents a summary of economic and demographic characteristics of the study area. The scope of this review includes both county level research and census tract level research (Figure 3.18-1). Population, employment, the area economy, a historical perspective of economic development, and Environmental Justice (EJ) are key areas of discussion.

3.18.1 Population

The proposed project involves improvements to the existing Freeport Harbor Channel. The study area includes Brazoria County as well as City of Freeport, Oyster Creek City, Town of Quintana, and Surfside Beach. Vessels enter the Freeport Harbor Channel southeast of Freeport, immediately passing southeast of Quintana, northwest of Surfside Beach continuing along the Freeport Harbor Channel eastward towards Brazos Harbor. The channel extends north into the Freeport Harbor where it parallels the City of Freeport shoreline.

The proposed project is located in Brazoria County with a 2000 population of 241,767 persons. Brazoria County maintained steady growth, increasing by 13% between 1980 and 1990 and by 26% between 1990 and 2000 (Table 3.18-1). The City of Freeport, population 12,717, is located on the north side of Freeport Bay and Oyster Creek (population 1,200), borders the northeastern part of the project area, while Quintana (population 44) and Surfside Beach (population 764) comprise the southern portion of the project area.

TABLE 3.18.1

POPULATION TRENDS 1980–2000

	Population			Percent Change		
Place	1980	1990	2000	1980–1990	1990–2000	1980–2000
Brazoria County	169,587	191,707	241,767	13%	26%	43%
State of Texas	14,225,513	16,986,510	20,851,820	19%	23%	47%

Source: U.S. Census Bureau, 1990, 2000a.

As shown in Table 3.18-2, population projections provided by the Texas State Data Center (TSDC) indicate that growth in Brazoria County is expected to grow at a faster rate as compared to state growth rates through 2040. Brazoria County is projected to grow 78% from 2000 to 2040 while the State of Texas is projected to grow 72% during the same time.

PBSJ
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Figure 3.18-1
Census Tracts - Freeport Channel

Prepared for: Tricia LaRue

Job No.: 441591.00	Scale: 1:30,000
Prepared by: EMons/APugh	Date: 08/30/2006

File: N:/44159100/Projects/3_18_1_Census.mxd

Legend

Census Tracts Study Area

CensusTracts

- 6642
- 6644

2,500 1,250 0 2,500

Feet

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TABLE 3.18.2

POPULATION PROJECTIONS 2000–2030

Place	Population					Percent Change			
	2000	2010	2020	2030	2040	2000–2010	2020–2030	2030–2040	2000–2040
Brazoria County	241,767	287,859	336,321	384,104	430,456	19%	17%	12%	78%
State of Texas	20,851,820	24,330,643	28,005,792	31,830,579	35,761,159	17%	14%	12%	72%

Source: TSDC, 2004.

3.18.2 Population Demographics

This section provides an assessment of various population demographics. Provided below is information collected for the following categories: family households, household tenure, average per capita income, average median household incomes, and poverty levels.

The U.S. Census Bureau classification of "family households" (homes that are occupied by a family) is the dominant form of household composition in the study area (Table 3.18-3). Households categorized as married-couple family households in the City of Freeport represent 74%, followed by 69% for Oyster Creek. The communities of Quintana and Surfside are similar with 55% and 56%, respectively.

TABLE 3.18.3

HOUSEHOLD COMPOSITION, 2000

Area	Number of Households	Family Households	% Family Households	Nonfamily Households	% Nonfamily Households	Average Household Size	Average Family Size
CT 6642	966	603	62	363	38	2.34	2.84
CT 6644	2,320	1.766	76	554	24	3.06	3.57
Freeport	4,163	3,099	74%	1,064	26%	3.05	3.59
Oyster Creek	440	304	69%	136	31%	2.64	3.14
Quintana	20	11	55%	9	45%	1.90	2.18
Surfside Beach	352	197	56%	155	44%	2.15	2.68
Brazoria County	81,954	63,128	77%	18,826	23%	2.82	3.23
State of Texas	7,393,354	5,247,794	71%	2,145,560	29%	2.74	3.28

Source: U.S. Census Bureau, 2000b.

As reported in the Texas Housing Affordability Index (TAMU, 2005a), defined as the ratio of median family income to the income required to qualify for an 80%, fixed-rate mortgage to purchase the median-priced home, the affordability index in Brazoria County has increased from 2.63 in 1999 to 3.55 in 2004. The average price from January 1990 to January 2005 has increased from $61,400 to $125,200 with the median price increasing from $56,200 to $98,000 during the same time (TAMU, 2005b).

"Household tenure" is a category that distinguishes between owner-occupied housing units and renter-occupied housing units. The 2000 census data within the study area shows that owner-occupied housing units are more abundant in Brazoria County and the State of Texas with 26% and 36%, respectively than renter occupied units in the study area, except for Quintana (Table 3.18-4).

TABLE 3.18.4

STUDY AREA HOUSEHOLD TENURE, 2000

Area	# Occupied Housing Units	Owner Occupied Units	% Owner Occupied Units	Renter Occupied Units	% Renter Occupied Units
CT 6642	960	639	67	321	33
CT 6664	2,317	1,415	61	902	39
Oyster Creek	440	300	68%	140	32%
Quintana	20	10	50%	10	50%
Surfside Beach	352	207	59%	145	41%
Brazoria County	81,954	60,674	74%	21,280	26%
State of Texas	7,393,354	4,716,959	64%	2,676,395	36%

Source: U.S. Census Bureau, 2000b.

Table 3.18-5 shows the age characteristics for the study area. Relative to the state, the study area population generally had higher percentages of the population within the following age cohorts: 5 and under (9.6%), 5 to 14 (19.2%), and 15 to 19 (8.7%). The study area population generally had lower proportions than the state for the following age cohorts: 20 to 34 (21.4%), 35 to 49 (21%), 50 to 64 (11.5%), and 65 and over with 8.5%.

TABLE 3.18-5

AGE CHARACTERISTICS OF THE STUDY AREA, 2000 (YEARS OF AGE)

Place	Under 5	5 to 14	15 to 19	20 to 34	35 to 49	50 to 64	65 and over	Total Persons
CT 6642 BG 3	40	94	40	141	263	195	99	872
CT 6644 BG 6	115	219	128	268	268	171	162	1,331
Freeport	1,274	2,552	1,143	2,791	2,572	1,346	1,030	12,708
Oyster Creek	103	189	95	227	268	182	128	1,192
Quintana	0	3	2	4	14	9	6	38
Surfside Beach	35	83	37	127	237	160	84	763
Brazoria County	18,708	38,625	18,592	48,856	62,009	33,647	21,330	241,767
State of Texas	1,624,628	3,285,376	1,636,232	4,701,487	4,738,416	2,579,338	2,286,343	20,851,820

Source: U.S. Census Bureau, 2000b.
BG = Block Group; CT = Census Tract.

The study area median household incomes in 1999 ranged from the lowest ($25,500) in Quintana to the highest ($37,778) in Surfside Beach (Table 3.18-6). Poverty levels were also examined in the study area. The percentage of persons living below the poverty line in 1999 ranged from 12.6% of the population in Surfside Beach to 22.9% of the population in Freeport.

TABLE 3.18-6

INCOME CHARACTERISTICS OF THE STUDY AREA, 2000

Place	Number of Persons	Per Capita Income	Median Household Income	Number Below Poverty	Percent Below Poverty
CT 6642 BG 3	872	$26,362	$42,308	97	11.3
CT 6644 BG 6	1,267	$18,205	$22,425	323	25.5
Freeport	12,717	$12,426	$30,245	2,896	22.9
Oyster Creek	1,200	$15,000	$35,144	225	19.2
Quintana	44	$15,900	$25,500	8	18.2
Surfside Beach	764	$24,081	$37,778	94	12.6
Brazoria County	241,767	$20,021	$48,632	23,465	10.2
State of Texas	20,851,820	$19,617	$39,927	3,117,609	15.4

Source: U.S. Census Bureau, 2000b.

As shown in Table 3.18-6, poverty levels for the study area, with the exception of Surfside Beach, were relatively high in comparison to the State of Texas (15.4%).

Table 3.18-7 shows the educational attainment of persons within the study area and the State of Texas. Generally speaking, the study area has a higher percentage of persons that attended high school but did not receive a diploma than the state. The study area has a lower percentage of persons with an Associates Degree, Bachelor's Degree or graduate or professional degree than the state with the exception of Surfside Beach for persons with an Associates Degree (5.4%).

TABLE 3.18-7

EDUCATIONAL ATTAINMENT OF THE STUDY AREA, 2000

Place	Less than 9th Grade	9th to 12th Grade, no Diploma	High School Graduate	Some College	Associates Degree	Bachelor's Degree	Graduate or Professional Degree
Freeport	22.6 %	22.3 %	28.0 %	18.3 %	3.4 %	3.3 %	2.1 %
Oyster Creek	8.9 %	24.8 %	35.2 %	21.5 %	4.5 %	3.1 %	1.9 %
Quintana	18.2 %	27.3 %	15.9 %	38.6 %	0.0 %	0.0 %	0.0 %
Surfside Beach	2.3 %	17.0 %	27.7 %	32.3 %	5.4 %	8.4 %	6.8 %
Brazoria County	7.8 %	12.6 %	27.2 %	25.8%	6.9 %	13.8 %	5.9 %
State of Texas	11.5 %	12.9 %	24.8 %	22.4 %	5.2 %	15.6 %	7.6 %

Source: U.S. Census Bureau, 2000b.

3.18.3 Employment

According to the Texas Workforce Commission (TWC), the largest percentages of jobs in Brazoria County are within Manufacturing, Trade, Transportation and Utilities, and Leisure and Hospitality service sectors. First quarter employment in 2001 had a total of 59,998 persons employed in Brazoria County, of which, 29% were employed in manufacturing, 22% in trade, transportation and utilities, followed by 18% in construction. The workforce increased 0.4% from 2001 to 2003 with a total of 60,225 persons employed in Brazoria County. The top three employment sectors for the first quarter were trade, transportation and utilities (23%), manufacturing (21%) and construction, with 17%. The workforce grew 1.6% from 2003 to 2005 with 61,159 employed in the first quarter of 2005. The top three employment sectors were trade, transportation and utilities, with 23%, followed by manufacturing and construction with 18%. During the same period, the unemployment rate increased from 5.1% in 2001 to 7.3% in 2003 (TWC, 2005).

Table 3.18-8 shows the class of worker within the study area. According to the U.S. Census Bureau 2000 data, the study area is similar to the State of Texas when looking at the percentage of private wage and salary workers and has a slightly lower percentage of government workers. Quintana has a much higher percentage of self-employed workers while Freeport has a lower percentage of self-employed workers when compared to the county and state.

TABLE 3.18-8

CLASS OF WORKER IN THE STUDY AREA, 2000

Place	Private Wage and Salary Workers	Government Workers	Self-employed Workers (not incorporated business)	Unpaid Family Workers
Freeport	83.7 %	10.5 %	4.7 %	1.0 %
Oyster Creek	79.7 %	12.2 %	8.1 %	0.0 %
Quintana	76.9 %	0.0 %	23.1 %	0.0 %
Surfside Beach	77.1 %	10.9 %	10.9 %	1.2 %
Brazoria County	79.0 %	14.6 %	6.0 %	0.3 %
State of Texas	78.0 %	14.6 %	7.1 %	0.3 %

Source: U.S. Census Bureau, 2000b.

Approximately 26,000 Texas jobs are related to the activity within the BRHND. Approximately 8,100 jobs are directly generated by cargo and vessel activity in the Port, with Brazoria County residents holding 77% of those jobs. Table 3.18-9 provides a list of the top 20 major employers within the Freeport area. The top employers are primarily oil industry/port-related enterprises, healthcare, government, and retail industries.

TABLE 3.18-9

STUDY AREA MAJOR EMPLOYERS, 2004

Top 20 Study Area Employers	Number of Employees
Dow Chemical USA (TX Operations)	5,000
U.S. Contractors	2,000 – 4,000
Tx. Dept. of Criminal Justice	2,575
Brazosport ISD	1,800
Phillips 66 Company	1,356
Brazoria County Government	1,156

TABLE 3.18-9 (Cont'd)

Top 20 Study Area Employers	Number of Employees
Gulf States	838
BASF	800
Amoco Chemical	750
Monsanto	630
Benchmark Electronic	575
Wal-Mart	510
Brazosport Memorial Hospital	486
Oxy-Chem, Inc.	464
Kroger	350
Mallinckrodt Medical	165
Shintech	158
American Rice, Inc.	150
Rhone-Poulenc	150
U.S. Postal Service	140

Source: City of Freeport, 2004.

Table 3.18-10 shows the place of work for workers in the study area. The study area percentages are similar to the State of Texas when comparing working within the state of residence; however, the block groups and cities within the study area had a much higher percentages of persons that work within the county of residence when compared to the county or state. Only the City of Freeport is similar to the state when comparing working within the place of residence. Generally speaking, the block groups and cities within the study area has a higher percentage of persons working outside their place of residence while working within their county of residence.

TABLE 3.18-10

PLACE OF WORK FOR WORKERS IN THE STUDY AREA, 2000

Place	Work in State of Residence	Work Outside State of Residence	Work in County of Residence	Work Outside County of Residence	Work in Place of Residence	Work Outside Place of Residence
Freeport	96.8 %	3.2 %	89.7 %	7.1 %	40.2 %	59.8 %
CT 6642 BG 3	99.2%	0.8%	99.2%	20.0%	16%	84.0
CT 6644 BG 6	100%	0%	97.9%	2.1%	39.3%	60.7%
Oyster Creek	99.4 %	0.6 %	90.3 %	9.2 %	9.9 %	90.1 %
Quintana	100.0 %	0.0 %	100.0 %	0.0 %	23.0 %	76.9 %
Surfside Beach	99.0 %	1.0 %	78.5 %	20.6 %	16.0 %	84.0 %
Brazoria County	99.1 %	0.9 %	59.7 %	39.4 %	16.2 %	50.2 %
State of Texas	99.0 %	1.0 %	78.6 %	20.4 %	44.3 %	35.6%

Source: U.S. Census Bureau, 2000b.

As shown in Table 3.18-11, workers that live in Quintana have a longer travel time to work with more than 77% traveling 15 minutes or more. Workers in the City of Freeport have the least amount of travel time to work within the study area and when compared to the State of Texas.

TABLE 3.18-11

TRAVEL TIME TO WORK IN THE STUDY AREA, 2000

Place	Worked at Home	Less than 5 Minutes	5 to 15 Minutes	15 to 25 Minutes	25 to 45 Minutes	45 Minutes or More
CT 6642 BG 3	3.5%	7.5%	17.1%	31.8%	18.1%	25.5%
CT 6644 BG 6	0%	0%	56.1%	33.5%	7.4%	2.9%
Freeport	0.7 %	4.7 %	42.3 %	28.0 %	13.6 %	10.7 %
Oyster Creek	4.5 %	1.9 %	33.1 %	33.0 %	17.0 %	10.5 %
Quintana	0.0 %	0.0 %	23.1 %	53.8 %	0.0 %	23.1 %
Surfside Beach	2.2 %	6.7 %	20.1 %	33.7 %	15.6 %	21.7 %
Brazoria County	2.2 %	2.7 %	21.7 %	26.1 %	28.2 %	19.1 %
State of Texas	2.8 %	3.0 %	24.7 %	30.0 %	25.0 %	14.5 %

Source: U.S. Census Bureau, 2000b.

3.18.4 Economics

3.18.4.1 Historical Perspective

The Port Freeport area has been an important trade and shipping area since the nineteenth century. The navigation of the Port of Freeport began as early as 1821, when Stephen F. Austin chose the mouth of the Brazos River as a location for development of a deepwater port. In 1889, Congress authorized the Brazos River and Dock Company to construct a navigable channel between the mouth of the Brazos River and the Gulf of Mexico (BRHND, 2004).

The first dock and terminal facilities were constructed in the early 1950's and by 1961 the channel was dredged to a depth of 36 ft. Since that time, additional land has been purchased and developed for deepening and widening of the jetty system, construction of additional office and warehouse space, and numerous infrastructure improvements. The Port of Freeport was authorized in 1988 to accept, operate and maintain a Foreign-Trade Zone within its boundaries (BRHND, 2004).

On November 17, 1986, President Reagan signed "The Water Resources Development Act of 1986" which authorized the Freeport Harbor, Texas, 45-Ft Project. The project included the construction of the Surfside Jetty Park Complex. In 1999, the main entrance was rebuilt and widened and in 2000, the Deep Berthing Area was dredged to a depth of 70 ft (BRHND, 2004).

To diversify the Port's cargo base, in 2004, the Port has began major projects that include: a cool storage facility to handle temperature-sensitive commodities; construction of Berth 7, to accommodate vessels up to 48-ft draft; and the signing of a land lease agreement with Freeport LNG to facilitate the construction of a liquefied natural gas receiving facility. These projects are in addition to multiple existing warehouses, transit sheds, dock facilities, and terminals (BRHND, 2004).

3.18.4.2 Current Regional Economics

The economy of Brazoria County and the Port of Freeport area is broadly based in manufacturing, agriculture, and fishing. The primary economic bases of the county include chemical manufacturing, petroleum processing, offshore production maintenance services, biochemical and electronic industries, commercial fishing and agriculture. The deep-water channel and port facilities, sports fishing services and tourism are major components of the county's economic base (BRHND, 2004).

Port of Freeport handles large volumes of commodities including petroleum products, agricultural products, and general cargo including animal feed, synthetic rubber, and automobiles (BRHND, 2004). The Port is ranked 16th in U.S. foreign tonnage and 12th in the U.S. in total tonnage (Texas Explorer, 2006; *The Alliance*, 2005b). Top import countries include Guatemala, Honduras, and Mexico and top export countries include Brazil, Honduras, Saudi Arabia, and the Dominican Republic, as well as various countries within Africa (Texas Explorer, 2006). As stated in the Comprehensive Annual Financial Report for the Port of Freeport (BRHND, 2004), if the Port Freeport harbor is deepened to 60 ft, it will boast the deepest-draft port facility on the Gulf of Mexico. The deepening project is currently in the feasibility stage in partnership with the USACE.

The Port of Freeport totaled over $1.9 million in payroll and related expenses in 2004, an increase of approximately $176,000 from 2003 (BRHND, 2004). As a result of local and regional purchases by the 8,100 employees, an additional 8,116 induced jobs are estimated to be supported in the regional economy; also 9,589 indirect jobs are supported by $675.9 million in local purchases by businesses supplying services at the marine terminals and by businesses dependent upon the Port of Freeport for shipment and receipt of cargo (Port Freeport, 2004).

The Port will become BASF Corporation's manufacturing base for nylon intermediates and polymers in North America with the construction of a $59 million polycaprolactam plant to be constructed on-site in 2006 (*The Alliance*, 2005a). The plant will build on existing operations and will add 10 permanent positions and construction will employ 190 workers at its peak (*The Alliance*, 2005a).

Gulf Coast Regional Spaceport Development Corporation is anticipating the long-awaited commercial spaceport to begin by the end of 2006. The spaceport site would encompass 3,000 acres near Demi-John and could generate thousands of high-tech jobs in the area (*The Alliance*, 2006e).

3.18.4.3 Tourism and Recreation

Tourism is a major contributor to the study area economy. The natural resources of the Gulf of Mexico provide extensive recreational opportunities in the Freeport area. Outdoor recreation in the area includes fishing, bird-watching, windsurfing, boating, jet skiing, swimming, shelling, and beach combing (among others).

Brazoria County was chosen as the location for this year's Texian Rally sponsored by The Texas Independence Trail Region. Brazoria County was chosen because of its association with the Texas Independence Trail as well as being the burial place of Stephen F. Austin before his grave was moved to Austin. In addition, the Masonic Oak in Brazoria County was the location of the first Masonic Lodge meeting held in Texas in 1835 (*The Alliance*, 2006f).

Freeport ranks as one of the top areas in the nation for diversity of species and number of species encountered (Texas Explorer, 2006). There are several marinas located within the Freeport area that support recreational as well as commercial fishing. There are numerous parks located within the area that provide beach access. The Freeport Bryan Beach is located southwest of the Village of Quintana at the end of FM 1495 and has a 3½-mile beach, named one of the cleanest beaches in Brazoria County. Follet's Island Beach is located near and northeast of the Village of Surfside Beach. It has 10 miles of beach and is used for swimming, picnicking and fishing. Quintana Beach Park includes such amenities as restrooms, showers, concession stand, board walks, picnic areas, and shaded pavilions for group rentals. On the property is the Coveney House that has a beach ecology lab that features hands-on displays. One of the newest parks is the Surfside Jetty Park which has a visitor's center, shuffle board, picnic tables, public showers, convenience store, restrooms, playground, horseshoe pits, lighted volleyball courts, and a sidewalk from the park to the jetty and beach. The Surfside Pedestrian Beach is located on the west side of Surfside Beach and does not allow vehicles. Amenities include portable restrooms located along the beach (City of Freeport, 2006).

The City of Freeport and TPWD have signed an agreement that authorizes planning, design, layout and clearance activities for the planned 2.9-mile oyster shell-surfaced trail, benches and signs for the Bryan Beach Park. This addition will help make the park a family oriented beach and establish an outdoor recreational area (*The Alliance*, 2006g).

Also in Freeport is a proposed marina on the Old Brazos River that could become the catalyst for downtown revitalization with restaurants, hotels and gift shops.

An agreement has been reached for Surfside Beach to lease a ½ acre, adjacent to city hall, for a nature trail and home for Surfside Beach's Save Our Beach Association (*The Alliance*, 2005c). The former Surfside Beach tourist center could house the group's monthly meetings as well as become a learning center for area residents and visitors.

3.18.4.4 Community Values

Overall, the communities in the study area support development at the Port of Freeport. Future growth at the Port include new construction and expansion of existing facilities for companies such as Freeport LNG, BASF Corporation, Dow Chemical and ConocoPhillips. New jobs in the Brazosport community are a direct result of the expansion of the Port of Freeport. According to *The Alliance*, a newsletter distributed by the Economic Development Alliance for Brazoria County, Phase I of the Freeport LNG terminal has benefited Quintana by providing more than 400 jobs since 2005 and LNG anticipates an additional 60 plant operator positions once the site is open (*The Alliance*, 2006h). The community is expected to benefit from the long-term investment of Freeport LNG by projects such as the maintenance of beaches, roads, water system, and helping to keep the tax rate low. In addition, the facility would assist in retaining local jobs in the chemical industry. Even with the economic and community service benefits from facilities such as Freeport LNG, some residents are concerned about the size of the facility and the security demands that may ultimately affect Quintana's residents. Throughout Brazoria County, particularly in the project area, future projects include expansion of highways, new schools, new businesses, and water and sewer projects in Surfside Beach as big industrial employers such as BASF, Dow Chemical, and Conoco Phillips, expand their facilities (*The Alliance*, 2006b).

3.18.4.5 Commercial Fisheries

There is little commercial fishing in the Freeport area. Commercial fishing within the Galveston Bay system is a relatively moderate contributor to the Freeport area economy compared to other industry sectors.

3.18.4.6 Tax Base

In Texas, the state sales tax is 6.25%, with local sales/use tax not to exceed an additional 2.00%. Property taxes within Brazoria County are collected by the Brazoria County Tax Office. Table 3.18-12 provides a summary of property tax jurisdictions and tax rates for jurisdictions that affect the population living in the study area.

TABLE 3.18-12

PROPERTY TAX JURISDICTIONS, BRAZORIA COUNTY – 2005

Tax Jurisdictions	Tax Rate per $100 of Appraised Valuation
Brazoria County	0.347987
Brazosport ISD	1.5728
City of Freeport	0.71
City of Oyster Creek	0.4521
Town of Quintana	0.04
Village of Surfside Beach	0.49

Source: Brazoria County Appraisal District, 2005.

In Texas, property is appraised and property tax is collected by local (county) tax offices or appraisal districts, and these funds are used to fund many local needs, including public schools, city streets, county roads, and police and fire protection (Texas Comptroller of Public Accounts, 2006).

Activity at the Port of Freeport terminals generates $163.6 million in state and local taxes. Also, the Federal government receives $6.3 million of customs revenue from cargo activity at the public and private facilities (Port Freeport, 2004).

3.18.5 Environmental Justice

In compliance with Executive Order (EO) 12898 — Federal Action to Address Environmental Justice (EJ) in Minority Populations and Low-Income Populations, an analysis has been performed to determine whether the proposed project would have a disproportionate adverse impact on minority or low-income population groups within the study area. The EO requires that minority and low-income populations do not receive disproportionately high adverse human health or environmental impacts and requires that representatives of minority or low-income populations, who could be affected by the proposed project, be involved in the community participation and public involvement process.

The data used in this study to determine the potential for disproportionate impacts to low-income and/or minority populations within the study area and the State are presented in tables 3.18-13 and 3.18-14. The information is based on 2000 U.S. Census Bureau state, county, and block group level data for ethnicity and income.

TABLE 3.18-13

DETAILED 2000 POPULATION CHARACTERISTICS IN STUDY AREA

		Population of One Race/Not Hispanic or Latino								
Area	Total Population	White	Black or African American	American Indian/ Alaskan Native	Asian	Native Hawaiian other Pacific Islander	Hispanic or Latino of any race	Total Minority Population	Median Household Income	% Below Poverty
CT 6642 BG 3	872	90.3	2.8	0.2	0.0	0.0	2.3	9.7	$42,308	11.3
CT 6644 BG 6	1,267	56.7	19.9	0.0	0.0	0.00	23.4	43.3	22,425	25.5
Freeport	12,717	33.0	13.2	0.1	0.3	0.1	51.6	67	$30,245	22.9
Oyster Creek	1,200	75.7	4.7	0.4	0.4	0.0	17.6	24.3	$35,144	19.2
Quintana	44	81.8	0.0	0.0	0.0	0.0	18.2	18.2	$25,500	18.2
Surfside Beach	764	90.1	3.1	0.3	0.0	0.0	2.4	9.9	$37,778	12.6
Brazoria County	241,767	65.3	8.3	0.4	1.9	< 0.1	22.8	34.7	$48,632	10.2
State of Texas	20,851,820	52.4	11.3	0.3	2.6	< 0.1	32.0	47.6	$39,927	15.4

Source: U.S. Census Bureau, 2000b.

TABLE 3.18-14

PERCENTAGE OF LIMITED ENGLISH PROFICIENCY PERSONS IN STUDY AREA

Area	Percent of Persons that Speak English “Not Well”	Percent of Persons that Speak English “Not at All”
CT 6642 BG 3	1.1	0.0
CT 6642 BG 6	3.7	0.7
Freeport	8.9	5.1
Oyster Creek	1.1	0.5
Quintana	0.0	0.0
Surfside Beach	1.2	0.0
Brazoria County	3.0	1.2
State of Texas	4.7	2.7

Source: U.S. Census Bureau, 2000b.

In terms of ethnicity, the population living within the study area block groups is less ethnically diverse than Brazoria County and the State of Texas (Table 3.18-13). The number of White persons within the BG 2 and BG 3 are 77.6% and 90.3%, respectively. This is much higher than Brazoria County (65.3%) and substantially higher than Freeport (33%) or the state, with 52.4%. The percentage of Hispanics within BG 3 (2.3%) and Surfside Beach (2.4%) is substantially lower than Brazoria County (22.8%), the state (32%), and Freeport (51.6%). The percent minority persons within the study area ranges from the lowest, 9.7% in CT 6642 BG 3, to the highest, which was Freeport with 67%. Within the study area, Freeport has the largest percentage of minority population (67%), which is predominately composed of Hispanic and African American persons. This block group also has the highest percentage of people living below the poverty line in the study area, with 22.9%. The percent of persons living below poverty within the study area ranges from 10.2% in Brazoria County to 22.9% in Freeport. The percent of persons living below poverty within the study area block groups is, on average, higher than Brazoria County (10.2%) and the State of Texas (15.4%).

EO 13166, “Improving Access to Services for Persons with Limited English Proficiency (LEP)”, signed by President Clinton on August 11, 2000 calls for all agencies to ensure that their Federally conducted programs and activities are meaningfully accessible to LEP individuals. Table 3.18-14 contains the percent LEP population for the study area.

As shown in Table 3.18-14, a low percentage of persons in the study area do not speak English or have difficulty speaking English. Data for “Ability to Speak English” for the population five years and over indicates 1 to 9% of the population in the study area speak English “Not Well”, while zero to 5% of the population speak English “Not at All.” None of the LEP populations would be discriminated against as a result of the proposed project because steps would continue to be taken to ensure that such persons have meaningful access to the programs, services, and information that USACE provides. Therefore, the requirements of EO 13166 appear to be satisfied.

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