SECTION 3: AFFECTED ENVIRONMENT

This section discusses the affected environment of the proposed Grand Parkway Segment C.

3.1 LAND USE AND TRANSPORTATION PLANNING

Municipal governments in the State of Texas are granted broad authority to regulate land use within their respective jurisdictions. This authority allows considerable flexibility in the adoption of zoning and subdivision ordinances and land use and transportation plans. This section provides a description of historical and existing land uses and municipal and transportation plans in the proposed Grand Parkway Segment C study area.

Existing land uses within the study area were identified from aerial photography, TxDOT county maps, and USGS topographic maps. The resulting Environmental Constraints Map (Exhibit 15) was verified with field reconnaissance efforts conducted in June 2010. Supplemental information was also obtained from municipal planning documents, other pertinent documents, and interviews with municipal and state agency staff.

3.1.1 Historical Development Patterns

The study area falls within the Houston-Galveston-Brazoria Consolidated Metropolitan Statistical Area (HGB CMSA), which is made up of three Primary Metropolitan Statistical Areas (PMSA): the Houston PMSA (Chambers, Fort Bend, Harris, Liberty, Montgomery, and Waller counties), the Galveston – Texas City PMSA (Galveston County), and the Brazoria PMSA (Brazoria County).

Primarily rural until the 1970s, the suburban growth of Fort Bend and Brazoria counties has been closely tied to the economic prosperity of Houston. The lower cost of land in Fort Bend and other counties surrounding Houston has drawn residential development away from the central city to areas more affordable for the developer and homeowner. As bedroom communities increased through the 1980s, decentralization of Houston continued as jobs and retail sales began to follow homeowners to the suburbs. Over time, the Houston region has become a central city surrounded by smaller edge cities, large enough to support shopping and labor markets.

Much of the area in the Houston vicinity has been developed in a “leap frog” pattern. New subdivisions are built in outlying areas when land closer to the city is still undeveloped. Fitting this growth model, land in the region is developed if it is relatively close to existing subdivisions, is near transportation arteries and is large enough to make the private construction of stand-alone infrastructure economically efficient (Fort Bend Parkway Toll Road Traffic and Revenue Study, 1999).

This type of growth, master-planned communities developed by private entities, is rapidly occurring in the study area. Such communities are large enough to lower the per-unit costs of private development of capital infrastructure while at the same time offering open space and community facilities. Often, such communities are annexed by surrounding cities in efforts to

improve that city's tax base, providing the residents of the affected area approve it by referendum. Houston and its surrounding edge communities have typically expanded in this way (Fort Bend Parkway Toll Road Traffic and Revenue Study, 1999).

3.1.2 Existing Land Use

Located on the Gulf Coastal Plain, the study area covers 107,980 acres within two counties. The majority of the study area is located in the southeast portion of Fort Bend County. A smaller portion is located in northwest Brazoria County. The area falls within Gulf Coast State Planning Region 16 and is governed by the H-GAC of Governments. The study area is least utilized for commercial and industrial uses. Most commercial uses within the study area are concentrated along Crabb River Road, with the majority of the land utilized for agricultural, scattered residential clusters (particularly in the northern study area), Brazos Bend State Park, the Darrington Unit of the TDCJ, and George Ranch Historical Park. The bulk of the industrial uses include Thompsons Oil Field. The State of Texas owns two large land operations within the study area: Brazos Bend State Park and the Darrington Unit of the TDCJ. Sections 3.3.2.3 and 3.3.2.4 include discussions of Brazos Bend State Park.

The Darrington Unit is a prison farm located entirely within the Brazoria County portion of the study area. This 6,770-acre facility houses 1,836 prisoners at medium, minimum, and administrative segregation custody levels. Although the prison farm would seem to be a considerable constraint due to the security requirements of the facility, the TDCJ, in coordination with TxDOT (Exhibits 11 and 15), indicated that prison farm property could be considered in evaluating alternatives under the following conditions:

- Routes should only be considered that would not bisect the prison farm (i.e., follow the northern boundary or follow the southern boundary of the prison farm)
- Only prison farm land could be impacted
- Prison facilities could not be impacted
- Prison security must be maintained (i.e., buffer zone, illumination)
- Prison farm drainage in low-lying areas is a regular problem and must be considered

3.1.2.1 Urban Development

The most intensive development is found in the rapidly growing northern third of the proposed Grand Parkway Segment C study area. Suburban residential and commercial growth has occurred along Crabb River Road near US 59. The Memorial Hermann Sugar Land Hospital complex is located on the northwest corner of the US 59/Grand Parkway interchange, and the Riverpark Shopping Center is located on the northeast corner of the interchange. Newer and planned urban development extends to the south and west. Subdivisions are currently under construction on both the east and west sides of Crabb River Road, south and west of the intersection of Crabb River Road and FM 762 along the western edge of

Berdett Road and south of Smithers Lake along FM 762. Commercial uses are concentrated along Crabb River Road. The remainder of the study area is characterized by agricultural land uses, primarily rice farms, scattered small residential clusters, parklands, and the TDCJ as discussed above. The Brazos River and numerous tributaries cross the primarily level study area as well as the extensive irrigation system implemented by rice farmers.

Recent development, primarily in the northern third of the study area, is in the form of suburban style master-planned communities consisting of fairly high-density, single-family homes along curvilinear streets. Subdivisions within the study area include Greatwood, Greatwood Village, Greatwood Knoll, Bridlewood, Bridlewood Estates, Canyon Gate, Crestwood Tara, Brazos Crossing, Brazos Village, Canyon Lakes at the Brazos, Lakes of Williams Ranch, Brazos Village, Ridge Estates, Brazos Gardens, River Run at the Brazos, Bonbrook Plantation, Sovereign Shores Estates, Summer Lakes, and The Retreat (Exhibit 15).

Reading Jr. High School and George Ranch High School are located along FM 762 east of Bridlewood Estates (Exhibit 16).

The residential pattern of recent developments contrasts sharply with the rural nature of the traditional housing stock of the area where small clusters of homes or individual farm homesteads dot FM roads. Many of the residences in more rural settings include farm-related structures such as garages, barns, storage building, and other agricultural outbuildings. Many also appear to be smaller than the new homes more recently built in the northern portion of the study area.

Commercial and industrial land uses in the study area are minimal. The bulk of the commercial land uses are in the northern third of the study area near residential communities. Travel-related gas stations and fast food restaurants are concentrated near US 59. Extending south along Crabb River Road are additional community services including auto mechanic shops, dry cleaners, storage areas, and mini-markets.

The primary industrial land uses in the study area include Thompsons Oil Field. Much of this area is wooded or used as pasture. Industry-related dirt roads and buildings owned by various oil companies course through this property.

3.1.2.2 Agricultural Land Uses

Agriculture dominates the land uses within the study area. While Fort Bend and Brazoria counties are characterized by numerous crops including cotton, grain sorghum, corn, rice, hay, and soybeans, cultivation within the study area appears to be dominated by irrigated rice fields. Data from the Natural Resources Conservation Service (NRCS) indicate that agricultural land use decreased while urban land use increased in Fort Bend County between 1987 and 1992. Cropland decreased from 39 percent to 32 percent and pasture decreased from 31 percent to 27 percent, while rangeland increased from 12 to 21 percent and urban land use increased from 12 to 15 percent. Brazoria County saw similar decreases in cropland, which dropped from 25 to 21 percent; and pasture, which fell from 44 to 39 percent. Rangeland decreased from 13 to 11 percent and urban land use decreased slightly from 13 percent in 1987 to 12 percent in 1992 (Soil Conservation Service [SCS], 1987, 1992).

The 2007 Census of Agriculture reports that the amount of land in farms in Fort Bend County decreased approximately 9 percent from 415,251 acres in 2002 to 382,740 acres in 2007, and the average size of farms increased from 266 acres in 2002 to 273 acres in 2007. Total market value of land and buildings purchased for farming in Fort Bend County increased from approximately 72.7 million in 2002 to $88.5 million in 2007. In Brazoria County, land in farms decreased from 613,891acres in 2002 to 528,957 acres in 2007. The average size of farms decreased from 250 acres in 2002 to 205 acres in 2007. Total market value of land and buildings purchased for farming in Brazoria County increased from approximately $97.3 million in 2002 to $115.7 million in 2007 (U.S. Department of Agriculture [USDA], 2007).

3.1.2.3 Transportation Land Uses

The study area falls between two major interstate-type highways, which serve as spokes in the wheel of highways connecting the City of Houston to its suburbs and provide for interstate commerce. On the western edge is US 59, which runs northeast to southwest. On the eastern edge is US 288, which runs north to south. The primary road through the study area is FM 762. Except for Crabb River Road in the northernmost section, the remainder of the area consists of a network of sparsely developed farm-to-market and county roads.

The Union Pacific Railroad and the Burlington Northern Santa Fe Railway (BNSF) provide rail service for the Houston metroplex. Only the BNSF has a facility in the study area. This is a freight line from Rosenberg to Galveston. There is no passenger rail service within the study area.

Four landing strips are located entirely or partially within the study area (National Oceanic and Atmospheric Administration [NOAA], 1997, 1998; TxDOT, 1994). All of these are private airstrips. Three of these airstrips are located southwest of the Lake Worthington Conservation Area. The fourth airstrip is located northeast of Rosharon.

3.1.3 Land-Use Planning

As described in Section 3.1.1, large-scale residential development in the Houston region occurs through the development of master-planned communities by private entities. There is very little land in the study area under municipal jurisdiction, although a larger percentage of land does fall within the extraterritorial jurisdiction (ETJ) of neighboring cities. Typically, these types of master-planned communities are eventually annexed by a city.

As shown in Exhibit 17, there are a number of cities and smaller incorporated areas that exist within or extend into the study area. The city limits of Rosenberg, population 30,618 extend into the northwest section of the study area, encompassing the southern ROW of FM 762 as well as a corridor along Dry Creek up to Berdett Road. Rosenberg's ETJ includes the portion of study area bordered by Berdett Road and Rice Field Road. Rosenberg has adopted a comprehensive plan but has no zoning ordinance in place. The city has adopted a standard subdivision ordinance that governs development within its ETJ.

Richmond, population 11,679 is the county seat of Fort Bend County. Its southern city limits abut the northeast side of Rosenberg. Richmond's ETJ also extends into the northwest portion of the study area, just north of Rosenberg's ETJ. Richmond has no zoning ordinance and no comprehensive plan in effect, although development within its ETJ is subject to Richmond's subdivision ordinance.

Richmond is the largest general-law city in Texas, which means that it cannot annex voluntarily, only through petition. As a result, the city has not annexed and expanded to the same degree and rate as some of its neighbors. However, Richmond is currently involved in a number of capital improvement projects, which include improvement of 7,904 square feet of the existing 28,201-square-foot Fort Bend Family Health Center, Inc., totaling over $600,000 provided by a federal grant (Recovery.Gov, 2011).

The City of Sugar Land is located northeast of the study area with a population of 78,817. The city limits of Sugar Land extend along the ROW of US 59 just inside the northeast boundary of the study area. This strip is not zoned. The Sugar Land ETJ extends well into the study area, encompassing much of the land east of Crabb River Road between US 59 and FM 2759. As with the cities mentioned above, development must adhere to the city's subdivision regulations and design standards as well as county standards. The city's comprehensive plan was adopted in 1993, and a comprehensive plan update was approved in 2005.

Additionally, there are a number of small, incorporated cities within the study area. Iowa Colony, 2010 population 1,170, is located in Brazoria County. Incorporated in 1973, this city consists of farms and rural homes. Iowa Colony's city boundaries extend into the northeastern corner of the study area 400 to 600 feet in width along either side of east/west CR 64, 382, 62 and 49 and north/south along CR 65. The ETJ of Iowa Colony extends ½ mile beyond its city limits. Ordinances, which govern development within the city's ETJ, include a subdivision ordinance, a mobile home ordinance, and a mobile home park ordinance.

The town of Sandy Point, with the 2000 population (U.S. Census does not provide 2010 population) of approximately 250, is located on both sides of FM 521 and extends north of CR 54 to south of Sandy Point Road. There are no ordinances that govern development within the town's ETJ in place at this time (Mowery, 2006).

The town of Thompsons, 2010 population 246, is located north of the study area. Its town limits abut the study area, encircling Smithers Lake Exhibit 17). The ETJ of Thompsons extends into the study area to Brazos Bend State Park. The town follows the subdivision and design standards of Fort Bend County. Bonney, 2000 population (U.S. Census does not provide 2010 population) of approximately 384, is located in the southeast section of the study area. Rosharon is a small, unincorporated community located in the southeastern corner of the study area at the intersection of FM 521 and FM 1462.

3.1.4 Transportation Planning

The H-GAC has been designated by the Governor of Texas as the Metropolitan Planning Organization (MPO) for transportation planning in the Gulf Coast State Planning Region. The Transportation Policy Committee provides policy

guidance and overall coordination for multi-modal transportation planning and development within the eight-county Houston-Galveston Transportation Management Area (H-GAC, 1989).

According to TxDOT, an MIS has been completed that examines widening US 59 from SH 6 to the Wharton county line. The segment of this project, which stretches from SH 6 to the future Grand Parkway, has been constructed and is open to traffic. The segment from Grand Parkway to the Wharton county line is a Priority II (Hunt, 1999). Additional plans include elevating sections of FM 521, as it is classified as a hurricane evacuation route. No capacity will be added to this roadway (Mackhart, 1999).

The FBCTRA has constructed a toll road (Fort Bend Parkway), which connects the Sam Houston Tollway and SH 6 in northeastern Fort Bend County. It opened on August 30, 2004, to approximately 6,000 commuters taking advantage of a new travel option (FBCTRA, 2009). A second leg of the toll road will extend 18 miles from SH 6 south across the Brazos River to the intersection with the proposed Grand Parkway. Transportation planning and environmental studies are underway for this section. A third leg, on the long-range-planning horizon, would extend from the proposed Grand Parkway southwest to SH 36 (Meyers, 1999).

The City of Rosenberg has included Grand Parkway and an extension of Reading Road on its city map. The segment of Reading Road would intersect with the proposed Grand Parkway and falls within the city's 10-year planning horizon (Braun, 1999).

3.2 GEOLOGY, SOILS, AND FARMLANDS

3.2.1 Physiography

The study area is located in the Gulf Coastal Plain physiographic province of Texas. The province ranges in character from a nearly smooth, featureless depositional plain bordered by shallow bays, barrier islands, and beaches along the Gulf of Mexico, to low, rolling hills extending inland to the Balcones Fault Zone. The plain rises gradually from sea level to an elevation of 200 feet above mean sea level (msl) within 50 to 100 miles of the coast. The generally flat relief of the Gulf Coastal Plain is broken by narrow valleys of small streams and broad valleys of larger streams that drain the region. At some locations, this topographical pattern is interrupted by the presence of such features as salt domes and fault scarps. Some scattered salt domes have surface expression in the form of broad mounds having as much as 100 feet of relief. Faults are common in the region but generally have little or no surface expression.

The land surface within the study area is characterized as broad, nearly level and gently sloping with poorly defined drainage patterns. The Brazos River and smaller headward-eroding streams cut the coastal plain. These streams flow through shallow, incised valleys that provide the most notable relief in topography. An extensive network of ditches and levees cross portions of the study area. The natural ground surface of the study area slopes coastward and ranges in elevation from about 85 feet msl near the northwestern corner of the study area to about 45 feet msl near the southeastern corner. Water surface elevations along the banks of the Brazos River range from 35 to 65 feet msl.

3.2.2 Geology

The study area is located on the northern flank of the Gulf Coast Geosyncline, a major center of sediment deposition since the middle to late Jurassic Period. The sedimentary rock and unconsolidated sediment beneath the study area are more than 30,000 feet thick and are differentiated into named stratigraphic units (i.e., formations) that dip and thicken towards the Gulf of Mexico from their landward margins. The younger formations crop out progressively coastward of the older formations and they dip Gulfward at angles slightly greater than the slope of the land surface. The result is a vertically stacked sequence of offlapped wedges whose outcrops occur as concentric bands that generally parallel the Texas coast.

The thick sequence of sedimentary rocks and unconsolidated sediments beneath the present day Gulf Coastal Plain reflect cyclic marine and continental deposition in the region through the Jurassic, Cretaceous, and Tertiary periods, culminating with predominantly fluvial deposits at the end of the Tertiary period. This pattern continued through the Pleistocene Epoch (i.e., early Quaternary period), during which sedimentation was largely controlled by sea level fluctuations associated with repeated, glacial and interglacial episodes (McGowen et al., 1976). The past 18,000 years (i.e., Holocene Epoch) has been characterized by erosion of the Pleistocene sediments and the deposition of alluvial sediments in the stream valleys of the region.

Examination of the "Geologic Atlas of Texas, Houston Sheet" (Bureau of Economic Geology, 1982), indicates the geologic units recognized within the study area are Miocene through Holocene in age and include, from oldest to youngest: the Fleming Formation of Miocene age; the Goliad Sand of Pliocene age; the Willis Sand, Bentley Formation, Montgomery Formation, and Beaumont Formation of Pleistocene age; and the alluvium of the Holocene age. Generally, each of these units is composed of sedimentary deposits of gravel, sand, silt, and clay. With the exception of Quaternary alluvial deposits, the Pleistocene-age Beaumont Formation is the only stratigraphic unit that crops out in the study area. Extensive deposits of Quaternary alluvium are unconformably deposited over the Beaumont within the Brazos River valley, which crosses the eastern portion of the study area.

As mentioned previously, faulting is common in the Texas Coastal Zone and is a product of natural geologic processes. Coastal faults are related to the gradual subsidence and tilting of the underlying strata and the adjustment of the overlying sediment. Radiating faults frequently occur above salt domes, which are common to the Texas Coastal Zone. These features have existed for thousands of years; however, there is clear indication that certain man-made activities have increased the activity of surface fault movement. Most of the documented active faults are located in areas of heavy withdrawal of groundwater, oil, and gas. These areas are also the areas that have experienced the greatest surface subsidence (Fisher et al., 1972). Fluid withdrawal can activate movement along faults by depressurizing subsurface sediments, which reduce the buoyancy and increases the overburden pressure on the aquifer. Coincidentally, the areas of the most active faults occur in areas of high groundwater withdrawal. According to the Natural Hazards of the Texas Coastal Zone (Brown et al., 1974), there are several active or potentially active faults located in the study area. Further interpretation of aerial photographs of the Texas Coastal Zone has identified linear features, topographic scarps, and/or anomalies in natural patterns, which have resulted in the inference of numerous active or potentially active faults.

Land-surface subsidence is another natural geologic process that is a function of the depositional environment of the Texas Coastal Basin. The natural rate of subsidence has been greatly accelerated due to increased utilization of groundwater resources. Excessive groundwater withdrawal is the primary cause of land-surface subsidence. As groundwater is removed the artesian pressure and piezometric surface declines allowing the water-saturated clay beds in the aquifer to become compressed. As the clay beds are compacted and dehydrated, they undergo a volume reduction that results in subsidence of the overlying land surface. Land subsidence already experienced is irreversible.

According to studies performed by the Harris-Galveston and Fort Bend counties Subsidence Districts, the land-surface at the study area has subsided approximately 1 to 2 feet between 1906 and 1995 (Exhibit 18). The rate of subsidence of the study area from 1987–1995 is estimated to be slightly less than 0.25 foot. Exhibit 19 illustrates predicted subsidence rates through year 2030. There are no subsidence maps for Brazoria County.

Salt domes are common throughout the Texas Coastal Zone. These subsurface features frequently have little or no surface expression, but create amenable conditions for the mining of sulfur and/or salt, and the production of oil and gas. Four salt domes have been identified within a 5-mile radius of the study area. The Thompsons Salt Dome, which is located beneath the Thompsons Oil and Gas Field, is the only salt dome within the study area. This salt dome is located west of the Brazos River near the Fort Bend-Brazoria county line. There are no documented radial faults associated with any of the salt domes near the study area.

3.2.3 Soils

Examination of the Soil Surveys for Fort Bend and Brazoria counties (SCS, 1960, 1979, 1981) reveals that a total of five general soils map classifications within the proposed Grand Parkway Segment C study area: (1) Lake Charles- Bernard-Edna; (2) Pledger-Brazoria-Norwood; (3) Edna-Bernard-Verland; (4) Asa-Norwood Brazoria; and (5) Edna-Aris-Kemah (Exhibit 20). The following is a description of each soil series located within the study area (SCS 1960; NRCS, 2010).

Fort Bend County

Asa Series

Soils of the Asa series are fertile and highly productive. They occupy the nearly level rarely overflowed bottom lands mainly along the Brazos River.

Beaumont Series

The soil of this series is fertile, moderately productive, and imperfectly drained. It occupies the nearly level to slightly depressed areas on the prairies.

Bernard Series

Soils of the Bernard series are dark, fertile, and productive. They occupy nearly level to sloping upland. Slopes exceeding 1 percent in gradient are susceptible to erosion when cultivated.

Edna Series

Soils of the Edna series are sandy and crusty and have a compact blocky subsoil. Their productivity is low. They occur on level, nearly level, and gently sloping areas.

Fulshear Series

Soils of the Fulshear series are moderately productive. They occupy gently sloping uplands and are susceptible to erosion when cultivated.

Hockley Series

Soils of the Hockley series are on gentle slopes, and they are well drained. They have low productivity but respond to management.

Katy Series

Soils of the Katy series are sandy, light colored, and of moderate to low fertility. They are mostly in the northern part of the county on nearly level areas. Small areas, however, are on slopes that are as much as 4 percent.

Kaufman Series

Soils of the Kaufman series are dark heavy soils of the bottom lands. They occur on frequently overflowed flood plains of large creeks and of the San Bernard River. Kaufman soils are fertile, but they are too often flooded to be used for crops. If cleared of trees, these soils would be very good for pasture.

Lake Charles Series

Soils of the Lake Charles series are dark clays occurring in the level to nearby level prairies. They are the most extensive soils in the county. The surface of these soils has a characteristic hog-wallowed microrelief.

Miller Series

The Miller series consists of reddish calcareous bottom-land soils with a heavy clay substratum. These soils are productive and drought resistant. They occur mostly in level and nearby level areas, but in a few places the surface is undulating and sloping.

Novasota-luke Series

The soils in this complex occur in an intricate pattern and are not mappable as separate units.

Norwood Series

The Norwood series consists of calcareous soils on the flood plain of the Brazos River. Most areas are nearly level, but a few consist of low parallel ridges and shallow swales. Norwood soils are well suited for field crops and pasture.

Pledger Series

The Pledger series consist of dark clay soils. They occupy level to nearly level flood plains of the Brazos and the lower San Bernard Rivers. Drainage of the surface improves this soil for cultivation.

Roebuck Series

The Roebuck series consists of brownish poorly drained soils occupying the natural depressions of the Brazos River flood plain. These soils have to be drained before they can be cultivated or used as improved pasture.

Waller Series

The Waller series consists of grayish acid wet soils occurring in small shallow rounded depressions on the Gulf Coastal Prairie. These depressions range from less than 1 acre to 25 or 30 acres in size, and they are generally from 6 to 10 inches lower than the surrounding prairie. Water stands in the depressions for long periods.

Yahola Series

The Yahola series consists of reddish sandy calcareous soils. They generally occur on natural levees along the present and old channels of the Brazos River. The surfaces are convex, and in places the slopes are as much as 1 percent.

Brazoria County

Aris Series

The Aris series consists of nearly level, somewhat poorly drained soils. These soils formed in ancient fluvial deposits. Slopes range from 0.2 percent to 1 percent.

Asa Series

The Asa series consists of nearly level to sloping, well drained, nonsaline soils. These soils formed in recent loamy fluvial deposits. Slopes range from 0.2 to 8 percent.

Beaumont Series

The Beaumont series consists of nearly level, poorly drained, nonsaline soils. These soils formed in ancient clayey coastal deposits. Slopes range from 0.1 to 0.3 percent.

Bernard Series

The Bernard series consists of nearly level, somewhat poorly drained, nonsaline soils. These soils formed in clayey ancient coastal deposits. Slopes range from 0.1 to 0.4 percent.

Brazoria Series

The Brazoria series consists of nearly level to gently sloping, somewhat poorly drained, nonsaline soils. These soils formed in recent clayey fluvial deposits. Slopes range from 0.1 to 5 percent.

Clemville Series

The Clemville series consists of nearly level somewhat poorly drained, nonsaline soils. These soils formed in recent loamy fluvial deposits that are underlain by clayey deposits. Slopes range from 0.2 to 0.5 percent.

Edna Series

The Edna series consists of nearly level and gently sloping, poorly drained, nonsaline soils. These soils formed in clayey ancient coastal deposits. Slopes range from 0.1 to 5 percent.

Kenney Series

The Kenney series consists of nearly level and gently sloping, well drained, nonsaline, sandy soils. These soils formed in ancient sandy fluvial deposits under prairie.

Lake Charles Series

The Lake Charles series consists of nearly level to sloping, somewhat poorly drained, nonsaline soils. These soils formed in ancient clayey coastal deposits. Slopes range from 0.1 to 8 percent.

Norwood Series

The Norwood series consists of deep, nearly level to sloping, well drained, nonsaline soils. These soils formed in recent loamy fluvial deposits. Slopes range from 0.2 to 8 percent.

Pledger Series

The Pledger series consists of deep, nearly level, somewhat poorly drained, nonsaline soils. These soils formed in recent clayey fluvial deposits. Slopes range from less than 0.1 to 0.6 percent.

Sumpf Series

The Sumpf series consists of nearly level, very poorly drained, nonsaline soils. These soils formed in recent clayey fluvial deposits. Slopes range from 0.1 to 0.5 percent.

The engineering properties of most of the soils located within the study area are similar. Variations occur as a result of the presence of coarser grained material associated with recent alluvial deposition along streams. The potential of these soils for urban uses is classified as medium, due in part to limiting features including high shrink-swell potential, wetness, clayey texture, and the susceptibility to flooding. Most of the soils typically consist of moderately to poorly drained fat clays and sandy clays with slow permeabilities. Within the study area, only the Norwood, Waller, Asa, Bernard, Hockley, Katy, Fulshear, Kenney, Clemville, and Edna soils are classified as not having a high shrink-swell potential or a wet, clayey texture. These well-drained soils developed on coarser, alluvial parent material, and as a result, these soils are also susceptible to flooding.

Soil erodibility is dependent on soil properties, the slope of the land, precipitation, and vegetation cover. The soil properties important in determining potential for erosion are three interrelated factors: permeability, structure, and consistency of the soil composition (Brady, 1990; Sopher and Baird, 1979). Each of these is dependent on particle size and chemical composition, including the amount of organic matter present, to determine the amount of soil loss (Brady, 1990; SCS, 1981). The slope will determine the velocity and volume of runoff. The impact of precipitation is determined by the amount and intensity of the rainfall, and vegetation cover determines the exposure of the soil to the erosive action by wind and rainfall. Based on these criteria, the erosion factor due to sheet and rill action, K (Universal Soil Loss Equation), is moderate for the soils in the study area (SCS, 1981; Wiedenfeld, 2001).

3.2.4 Farmlands

Many parts of the study area are farmed, but not all areas in agricultural use are considered for protection under the Farmland Protection Policy Act (FPPA). The FPPA, as detailed in Subtitle I of Title XV of the Agricultural and Food Act of 1981, provides protection to prime and unique farmlands, all of which are classified into four distinct types. The four types of farmland as defined by the FHWA Technical Advisory are (1) prime, (2) unique, (3) other than prime or unique and of statewide importance, and (4) other than prime or unique that is of local importance (FHWA, 1987). The State of Texas recognizes two of these categories: prime and statewide important farmland soils. Prime farmland soils, as defined by the USDA, are soils that are best suited to producing food, feed, forage, and oilseed crops. Such soils have properties that are favorable for the production of sustained high yields. Prime farmland soils typically produce the highest yields with a minimum input of energy and economic resources, and farming these soils has been found to keep damage to the

environment at a minimum. Prime farmland soils usually exist where adequate precipitation is available, and where mean temperature and length of growing season are favorable. The pH level of prime soils is neither extremely acidic nor extremely alkali. These soils are fairly permeable to water and air, contain very few rocks and are not excessively erodible by wind or water. Prime soils are not saturated for long periods, nor are they subject to frequent flooding during the growing season. Slopes are generally less than 6 percent. Prime farmland can include cropland, pastureland, rangeland, or forestland, but does not include land converted to urban, industrial, transportation, or water uses.

Statewide important farmlands are defined by the appropriate state or county agency as important for the production of food, feed, fiber, and forage or oilseed crops, but are lacking in one or more criteria to be classified as prime farmland. Each county in Texas in which a soil survey has been developed has a grouping system for classifying the relative suitability of soils for growing crops. These capability classes rank all soils including their limitations for crop production. Generally, the higher the suitability class, the better it is for cultivation.

The five general soil types in the project area each include prime and statewide important farmland components. The soil series within the study area recognized as prime or statewide important farmland by the state NRCS office are presented in Table 3-1. Each of the soil series is further identified in the table by the soils associations discussed in Section 3.2.3.

TABLE 3-1
PRIME AND STATEWIDE IMPORTANT FARMLAND SOILS WITHIN THE STUDY AREA

Soil Series	Prime Farmland	Fort Bend County Soils	Brazoria County Soils
Aris soils	X		X
Asa soils	X	X	
Asa-Pledger complex	X	X	
Beaumont clay soils	X	X	
Bernard soils	X	X	X
Brazoria soils	X		X
Clemville soils	X		X
Edna soils		X	X
Fulshear soils	X	X	
Hockley soils		X	
Katy soils	X	X	
Kaufman soils		X	
Kenney soils			X
Lake Charles soils	X	X	X
Miller soils	X	X	
Navasota-juka complex		X	
Norwood soils	X	X	X
Pledger soils	X	X	X
Roebuck soils		X	
Sumpf soils			X
Yohola soils	X	X	

Source: NRCS (2011).

3.3 SOCIAL CHARACTERISTICS

3.3.1 Population Characteristics

Reflective of the growth pattern of Houston and its environs as discussed in Section 3.1.1, over the last 30 years the population of the HGB CMSA has increased dramatically as shown in Table 3-2. Although the rate of growth has slowed since 1970 when the population increased by 43.0 percent over that decade, growth is still relatively high, at 19.7 percent during the 1980s and 25.1 percent during the 1990s.

Population within the study area has increased. Although in 1960 Brazoria County contained almost twice as many people as Fort Bend County and was growing faster, the 1970s proved to be a boom for Fort Bend County. During this decade, Fort Bend's population increased by 150.3 percent from 52,314 to 130,962. Brazoria County grew 56.6 percent over the same period from 108,312 to 169,587. Fort Bend County has continued to outpace Brazoria County but at a slower rate since that time. Between 1980 and 1990, Fort Bend County and Brazoria County grew 72.1 percent and 13.0 percent, respectively. In the 1990s, Brazoria County's growth rate has increased 26.1 percent while Fort Bend County's growth has slowed 57.2 percent for the decade. However, over the last decade, the growth rate in Brazoria and Fort Bend counties increased to 29.5 and 65.2 percent, respectively. Overall, from 1960 to 2010, Fort Bend County's average annual rate of growth is more 4 times that of Brazoria County.

The cities of Richmond (population 11,679) and Rosenberg (population 30,618), located north of the study area, grew steadily through the 1960s and at a faster rate through the 1970s. While their rates of growth slowed in the 1980s, population in the 1990s did increase once again. The City of Sugar Land (population 78,817), in the northern portion of the study area but closer to the City of Houston, grew very rapidly between 1970 and 2000 with growth of at least 158 percent each decade. Between 2000 and 2010, growth continued (24.5 percent), however, at a slower rate than the previous decades. Although these three cities lie primarily outside of the study area, their population growth patterns reflect those of the region.

Population in the study area is expected to continue increasing. As shown in Table 3-3, projections suggest that between 2010 and 2040, Brazoria and Fort Bend counties will increase 45.6 and 98.3 percent, respectively. These percentages are only slightly less than the projected percentage change of the State of Texas for the same time frame.

Population of Sugar Land is anticipated to increase by approximately 28.4 percent between 2010 and 2020; however, population growth is anticipated to slow to 3.5 percent between 2020 and 2030, then plateau over the next 20 years. Richmond is expected to increase by 5.3 percent between 2010 and 2020, and by 21.4 percent between 2020 and 2030. Rosenberg is expected to increase at 5.5 percent between 2010 and 2020 and 27.0 percent between 2020 and 2030.

TABLE 3-2
POPULATION GROWTH BY CITY, COUNTY, AND STATISTICAL AREA

	Population						Percent Change					Average Annual Growth Rate (%)
	1960	1970	1980	1990	2000	2010	1960–1970	1970–1980	1980–1990	1990–2000	2000–2010	1960–2010
Fort Bend County	40,527	52,314	130,962	225,421	354,452	585,375	29.1	150.3	72.1	57.2	65.2	26.9
City of Richmond	3,668	5,777	9,692	10,042	11,081	11,679	57.5	67.8	3.6	10.3	5.4	4.4
City of Rosenberg	9,698	12,098	17,995	20,183	24,043	30,618	24.7	48.7	12.2	19.1	27.4	4.3
City of Sugar Land	2,802	3,318	8,826	24,549	63,328	78,817	18.4	166.0	178.1	158.0	24.5	54.3
Brazoria County	76,204	108,312	169,587	191,707	241,767	313,166	42.1	56.6	13.0	26.1	29.5	6.2
HGB CMSA	NA	2,181,316	3,118,481	3,732,919	4,669,571	NA	NA	43.0	19.7	25.1	NA	NA
State of Texas *(1,000s)*	9,579	11,196	14,229	16,986	20,852	25,146	16.9	27.1	19.4	22.8	20.6	3.3

Source: U.S. Census Bureau (1960, 1970, 1980, 1990b, 2000, 2010).
NA – Not Available
HGB CMSA Average Annual Growth Rate is for 1960–2000 due to lack of information found for this geography on the 2011 Census website.

In Table 3-4, projected population for the year 2040 is identified for the study area, using Traffic Analysis Zones (TAZs) that were provided by the H-GAC. Also, Exhibit 21 shows the 31 TAZs that overlap into the study area. Portions of some TAZs overlap into areas that are outside the project study area, so the projected population is likely an over-estimation of the true 2040 population. Based on the H-GAC's projections, the study area population is expected to reach 158,096 by 2040.

As shown in Table 3-5, Fort Bend County, the white population is the largest ethnic grouping, representing 36.2 percent of the population. In Brazoria County, the white is also the largest ethnic grouping representing 53.2 percent of the population. Fort Bend has almost double the black population than Brazoria County. The Hispanic population percentages in Fort Bend County and Brazoria County are similar, 23.7 and 27.7 percent, respectively. As shown in Table 3-6, per capita incomes range from $20,021 to $24,985, both greater than the Texas average of $19,617. Fort Bend County has a higher population density of 405.3 persons per square mile than Brazoria, which contains 174.4 per square mile.

Table 3-7 displays 1999 and 2010 population and housing characteristics for the study area. The data are based on U.S. Census Bureau enumerations for census tracts (CTs), which together provide a social and economic representation of area population. Exhibits 22 and 23, respectively, show the location of the study area in relation to the 2000 and 2010 CTs. The study area covers large portions of nine CTs with a combined 2010 population of 67,771 persons. In 2010, there were approximately 21,056 residential housing units within the study area's CTs. Median household incomes of study area CTs within Fort Bend County range from $57,021 to $117,853. The median household incomes of study area block groups within Brazoria County range from $55,550 to $68,882. The study area's average median household income for CTs within Fort Bend County and Brazoria counties is $81,839. This is consistent with the Fort Bend County's overall median income of $79,845 and greater than Brazoria County's median household income of $65,607. Additionally, all CTs in the study area display median household incomes that are greater than the Texas state average ($49,646).

3.3.2 Social/Community Resources

Sensitive social and community facilities (schools, churches, and cemeteries), parks, and recreation areas were identified through a compilation of existing mapping sources (USGS topographic maps, TxDOT county maps), aerial photography, field reconnaissance surveys, and information provided by local and state agencies. The resulting site location information was mapped and is shown in Exhibit 15 (see Section 3.3.2.4, Public Lands, for additional information on public parks and recreation areas located in the study area).

TABLE 3-3
POPULATION PROJECTIONS BY CITY, COUNTY, AND STATISTICAL AREA

	Actual	Projected			Percentage Change			
Place	2000/2010+*	2020	2030	2040	2000/2010–2020	2020–2030	2030–2040	2000/2010–2040+
City of Richmond	13,493	14,212	17,257	20,334	5.3	21.4	17.8	50.7
City of Rosenberg	37,420	48,048	61,043	74,405	5.5	27.0	21.9	98.8
City of Sugar Land	83,819	101,422	105,000	105,000	28.4	3.5	0.0	25.3
Brazoria County	305,649	354,708	401,684	444,981	16.1	13.2	10.8	45.6
Fort Bend County	550,121	719,737	893,875	1.090,710	30.8	24.2	22.0	98.3
Houston CMSA	4,669,571	6,377,118	7,312,270	8,259,915	36.6	14.7	13.0	76.9
HGB CMSA+	4,715,407	6,443,005	7,400,720	8,398,069	36.6	14.9	13.5	78.1
State of Texas (*1,000s*)	25,388	29,650	33,712	37,734	16.8	13.7	11.9	48.6

Sources: U.S. Census Bureau (2010), Texas Water Development Board (TWDB, 2011a).

+2010 data is available and presented for all Places listed except for Houston CMSA and HGB CMSA; therefore, 2000 data is presented for Houston CMSA and HGB CMSA.

*TWDB was used as the primary source of data for this table; therefore, the estimated populations presented may differ from those estimate presented in Table 3-2 where U.S. Census Bureau was used as the primary source of data.

TABLE 3-4
STUDY AREA POPULATION PROJECTIONS BY TRAFFIC ANALYSIS ZONES (TAZ)

Fort Bend County		Brazoria County	
TAZ	Projected Population 2045	TAZ	Projected Population 2025
2134	14,192	1961	3,155
2135	7,811	1963	791
2255	7,247	1964	330
2256	6,875	1965	3,500
2257	5,864	1966	792
2258	23,527	1967	747
2265	6,044	1969	4,420
2266	11,051	1970	8,803
2267	946	1972	1,272
2274	15,879	1973	941
2275	5,624	1974	880
2308	2,711	1975	328
2311	5,785	1976	6,552
2314	5,919	1977	611
2315	1,870	1978	2,185
		1981	1,444
Subtotal	121,345		36,751
Study Area Total	158,096		

Source: H-GAC (2011).

TABLE 3-5
POPULATION ETHNICITY PROFILE FOR 2010

Place	Total Population	Number White	% White	Number Black	% Black	Number Hispanic	% Hispanic	Number Other	% Other
Fort Bend County	585,375	211,680	36.2	123,267	21.1	138,967	23.7	111,461	19.0
Brazoria County	313,166	166,674	53.2	36,880	11.8	86,643	27.7	22,969	7.3
Texas	25,145,561	11,397,345	45.3	2,886,825	11.5	9,460,921	37.6	1,400,470	5.6

Source: U.S. Census Bureau (2010).

TABLE 3-6
SOCIOECONOMIC PROFILE FOR 1999 AND 2010

Place	2010 Median Household Income ($)	2010 Per Capita Income ($)	Number of Housing Units	Persons Per Household+	Median Age	Population Density Persons per square mile+	% Below Poverty Level*	Limited English Population++
Fort Bend County	79,845	32,016	197,030	3.14	35.0	405.3	6.8	5.9
Brazoria County	65,607	27,529	118,336	2.82	35.1	174.4	9.4	4.5
Texas	49,646	24,870	9,977,436	2.74	33.6	79.6	14.1	8.4

Source: U.S. Census Bureau (2000, 2010).

* Percentage of people above 18 years of age.

+This U.S. Census information is not available for 2010; therefore, 2000 U.S. Census information is provided.

++Percentage of people above 5 years of age.

TABLE 3-7
DETAILED 1999 AND 2009 POPULATION CHARACTERISTICS BY STUDY AREA CENSUS TRACT**

Census Area	Population	Number of Housing Units	# White	% White	# Black	% Black	Hispanic Origin	% Hispanic	# Other	% Other	Per Capita Income ($)	Median Household Income ($)	% Below Poverty***	LEP[1] Population****
CT 6746* (CY 2000)	-		-	-	-		-	-						
BG 1	-	-	-	-	-	-	-	-						
BG 2	-	-	-	-	-	-	-	-						
CT 6746.01	3,762	1,429	2,739	72.8	252	6.7	304	8.1	467	12.4	62,863	115,417	0.5	0.1
BG 1	2,521	-	1,793	71.1	195	7.7	189	7.5	344	13.6				
BG 2	1,241	-	946	76.2	57	4.6	115	9.3	123	9.9				
CT 6746.02	7,641	2,543	5,021	65.7	717	9.4	980	12.8	923	12.1	45,255	117,853	1.5	1.0
BG 1	2,991	-	1,909	63.8	306	10.2	416	13.9	360	12.0				
CT 6746.03	5,999	2,060	3,045	50.8	877	14.6	1,707	28.5	370	6.2	27,149	71,529	8.3	3.1
BG 1	1,037	-	744	71.7	82	7.9	135	13.0	76	7.3				
BG 2	2,079	-	934	44.9	362	17.4	661	31.8	122	5.9				
BG 3	2,883	-	1,367	47.4	433	15.0	911	31.6	172	6.0				
CT 6746.04	4,607	1,415	1,118	24.3	1,529	33.2	901	19.6	1,059	23.0	35,761	98,285	7.0	1.5
BG 1	4,607	-	1,118	24.3	1,529	33.2	901	19.6	1,059	23.0				
CT 6747	11,165	3,551	3,555	31.8	2,978	26.7	2,213	19.8	2,419	21.7	28,473	81,691	7.3	4.9
BG 1	4,272	-	861	20.2	1,194	28.0	573	13.4	1,644	38.5				
BG 2	742	-	191	25.7	96	12.9	443	59.7	12	1.6				
BG 3	6,151		2,503	40.7	1,688	27.4	1,197	19.5	763	12.4				
CT 6755	11,151	3,874	4,027	36.1	2,215	19.9	3,986	35.7	923	8.3	31,198	70,321	7.2	3.3
BG 1	7,080	-	2,856	40.3	1,507	21.3	1,947	27.5	770	10.9				
BG 2	4,071	-	1,171	28.8	708	17.4	2,039	50.1	153	3.8				
CT 6756	5,808	2,152	3,920	67.5	89	1.5	1,697	29.2	102	1.8	25,307	57,021	6.2	2.9
BG 2	2,099	-	1,515	72.2	30	1.4	522	24.9	32	1.5				
CT 6618	5,385	1,866	2,896	53.8	341	6.3	1,489	27.7	659	12.2	26,579	68,882	11.4	8.1
BG 1	2,445	-	1,552	63.5	209	8.6	608	24.9	76	3.1				
BG 2	2,940	-	1,344	45.7	132	4.5	881	30.0	583	19.8				
CT 6619	12,253	2,166	4,380	35.7	3,483	28.4	4,106	33.5	284	2.3	10,485	55,550	12.8	3.5
BG 1	2,889	-	984	34.1	449	15.5	1,287	44.5	169	5.8				
BG 4	1,986	-	369	18.6	1,011	50.9	586	29.5	20	1.0				
Total/Avg for Census Tracts	67,771	21,056	30,701	48.7	12,481	16.3	17,383	23.9	7,206	11.1	32,563	81,839	6.9	3.2
Total/Avg for Block Groups	-	-	20,364	44.9	9,793	17.3	13,2220	27.7	6,134	10.2	-	-	-	

Source: U.S. Census Bureau (2000, 2010).

[1]LEP = Limited English Proficiency; CY = Census Year; BG = Block Group; CT = Census Tract

* Census Tract 6746 was subdivided into 4 subsets for 2010 data; however, the 2000 6746 Census Tract is included in the table so to present census data that was not available in 2010.

+ 2000 Data is presented because Census information was not available for 2010.

**CT 6747 BG3 did not exist in 2000 and was developed for the 2010 Census Data. Because poverty, income, and LEP Census Data are not available for 2010 BGs, this information is not presented above for the 2010 CT 6747 BG 3.

*** Percentage of people above 18 years of age.

****Percentage of people above 5 years of age.

3.3.2.1 Schools

Five independent school districts (ISD) exist within the study area, Lamar Consolidated Independent School District (CISD), Fort Bend, Angleton, Needville, and Alvin. Five schools exist within the study area, Reading Jr. High School, George Ranch High School, Susanna Dickinson Elementary, William Velasquez Elementary, and Manford-Williams Elementary School. The location of schools and school district boundaries are shown on Exhibits 15 and 16.

3.3.2.2 Churches and Cemeteries

The locations of churches and cemeteries in the study area are shown in Exhibit 15. In rural areas, local churches often serve as focal points for community interaction.

3.3.2.3 Parks and Recreation

A search of the Texas Parks and Wildlife Department (TPWD), Texas Outdoor Recreation Inventory database and field reconnaissance efforts revealed a number of parks and recreation areas in the study area. Parks and recreation areas range in size from small golf courses to large state parks and are owned and managed by a variety of entities including local development corporations, state and federal agencies, and private and nonprofit groups.

There are a number of parklands in the study area. Brazos Bend State Park covers 4,897 acres, with an eastern boundary of 3.2 miles fronting the Brazos River on the southeast border of Fort Bend County. This area was purchased by the state in 1976 and opened to the public in 1984. The George Observatory, owned and operated by the Houston Museum of Natural Science, is located here and houses a 36-inch telescope built primarily for public viewing and education. The George Ranch Historical Park, which is open to the public, is owned by the George Foundation (privately owned) and encompasses 500 acres. It is located within the 23,000-acre George Ranch. The Fort Bend Museum Association operates the outdoor living history exhibit on the park grounds.

Other recreation facilities in the area include a paintball course located just south of US 59 at Williams Way. There are a number of private recreational parks and trails within the planned communities of Greatwood, Riverpark, Canyon Gate, and Bridlewood.

The Lake Worthington Conservation Area, also within Fort Bend County, is a privately owned tract of land. The landowners have negotiated a conservation easement with the USFWS, which restricts development of the property. It is not open to the public.

No lands included in the National Park System or the National Trails System are located in the study area (National Park Service [NPS], 1999a). Additionally, no rivers classified as wild and scenic occur within the proposed Grand Parkway Segment C study area (NPS, 1999b).

3.3.2.4 Public Lands

In addition to small community parks, a few places are considered public lands. Included is the Brazos Bend State Park. Small parks located far from the alternative routes (discussed in Section 2) were not mapped, as the project is not anticipated to impact these areas.

Brazos Bend State Park, referred to in Section 3.3.2.3, is part of the state park system owned and managed by the TPWD. Prior to the state's purchase, most of the land was used for cattle grazing, pecan harvesting, and private hunting. Open to the public since 1984, the park has facilities for campers, a 21.6-mile hike/bike trail, group picnic pavilions, and a ½-mile wheelchair accessible nature trail. While most of the park is in the Brazos River floodplain, there are also areas of flat upland coastal prairies. In addition to the Brazos River, Big Creek runs diagonally through the park and creates, in combination with man-made levees, numerous lakes, sloughs and bayous (TPWD, 1999).

The George Observatory, dedicated in 1989, is owned and operated by the Houston Museum of Natural Science. Located in the Brazos Bend State Park because of the area's dark night skies and proximity to Houston, the observatory houses one of the largest telescopes consistently available for public viewing in the nation.

3.3.2.5 Institutional

The Darrington Unit is a large state-owned prison (6,770 acres) with large tracts of lands used for agricultural and farming operations (TDCJ, 2010).

3.3.3 Limited English Proficiency

Executive Order (EO) 13166, Improving Access to Services for Persons with Limited English Proficiency (LEP) required federal agencies to examine the services they provide and identify any need to services to those with LEP. The EO requires federal agencies to work to ensure that recipients of federal financial assistance provide meaningful access to their LEP applicants and beneficiaries. Failure to ensure that LEP persons can effectively participate in or benefit from federally assisted programs and activities may violate the prohibitions under Title VI of the Civil Rights Restoration Act of 1987 and Title VI regulations.

As indicated in Tables 3-6 and 3-7, the average percentage of population (5 years of age and older) within the study area CTs that is considered LEP is 3.2 percent, lower than Brazoria County (5.9 percent), Fort Bend County (4.5 percent), and the state (8.4 percent). CT 6618 has the greatest LEP population (8.1 percent) of the CTs; however, this is less than the state's average of 8.4 percent. During the public involvement process, as described in the Executive Summary, efforts, in accordance with policies at the time of involvement, were made to accommodate non-English speaking populations. Therefore, the requirements of EO 13166 have been satisfied.

3.4 ECONOMICS

3.4.1 Economic Conditions

Economic characteristics were examined for the greater HGB and more specifically for Brazoria and Fort Bend counties for a region-wide portrayal of the economic environment in which the proposed project is located. At a more local level, study area CTs were also examined. Nearby communities of Richmond, Rosenberg and Sugar Land are also profiled below.

3.4.1.1 Economic Characteristics of Area Population

The economic characteristics of the study area were derived from the 2010 Census where information was available; however, where 2010 information was not available, 2000 data was used. This is based on consistent availability of data for study area counties, municipalities, and CTs. Updates to the 2000 Census are currently not available for all of the study area municipalities and CTs; however, some updates (2005–2007 American Community Survey 3-Year Estimates) are available for study area counties and Metropolitan Statistical Areas (MSA) and have been updated accordingly.

Work Location

In the greater HGB CMSA, 81.6 percent of the working population is employed in the same county as their place of residence (Table 3-8). However, large numbers of Brazoria and Fort Bend County residents work outside their home counties. In Brazoria County, 59.7 percent work in the same county as their residence and 40.3 percent work in another county or outside the state. In Fort Bend County, more persons work outside their home county than within their home county. Among Fort Bend County residents, 36.6 percent work inside the county and 63.4 percent work outside Fort Bend County. For the two counties combined, 45.0 percent work inside their home counties and 54.4 percent work in other counties or outside the state.

For the nearby cities of Richmond and Rosenberg, 66.7 percent and 72.2 percent of workers, respectively, are employed in their home counties. In the City of Sugar Land, only 35.5 percent are employed inside Fort Bend County.

Table 3-8 shows comparable figures for the primary CTs within the study area, including tract 6619 in Brazoria County and tracts 6746, 6755, and 6756 in Fort Bend County. For these study area tracts, 48.4 percent work in their home counties, while 51.6 percent work outside their resident counties.

Median Travel Time to Work

Median travel time to work is consistent with the work location of area residents. As indicated in Table 3-8, for the HGB CMSA, median travel time to work is 28.8 minutes. Reflecting the suburban location of the study area, workers from that area have a longer commute to work, averaging 35.6 minutes daily. This is similar to travel time for Fort Bend County residents, of which almost two-thirds work outside of their home counties, and who have a median travel time of 32.3 minutes. Brazoria County residents, 59.7 percent of which are employed in their home counties, have a shorter travel time to work (28.0 minutes). The

TABLE 3-8
ECONOMIC CHARACTERISTICS OF REGIONAL AND STUDY AREA POPULATIONS 1999+

Characteristic	HGB CMSA		Brazoria County		Fort Bend County		Both Counties		City of Richmond		City of Rosenberg		City of Sugar Land		Study Area*	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Work Location																
Same County as Residence	1,698,933	81.6	62,594	59.7	59,932	36.6	122,526	45.0	2,942	66.7	7,398	72.2	10,836	35.5	5,555	48.4
Different County	368,206	17.7	41,346	39.4	102,513	62.7	143,859	53.6	1,455	33.0	2,844	27.8	19,391	63.6	5,836	50.9
Out of State	14,468	0.7	892	0.9	1,169	0.7	2061	0.8	11	0.2	4	0.1	283	0.9	84	0.7
Work At Home	51,644	2.5	2,264	2.2	4,731	2.9	6995	2.6	58	1.3	146	1.4	1,258	4.1	414	3.6
Median Travel Time to Work (Minutes)	28.8	NA	28.0	NA	32.3	NA	30.6	NA	26.7	NA	27.0	NA	29.6	NA	35.6	NA
Occupation																
Managerial & Professional	746,560	35.2	34,840	32.7	73,741	44.4	78,581	28.8	833	18.7	2,176	20.7	17,506	56.8	4,793	41.2
Tech., Sales, Adm. Supp.	289,480	13.6	13,661	12.8	16,534	9.9	30,195	11.1	1,070	24.0	2,109	20.1	2,288	7.4	1,494	12.9
Service	580,083	27.3	26,035	24.4	45,986	27.7	72,021	26.4	1,177	26.4	2,625	25.0	8,364	27.1	2,814	24.2
Farming, Forestry, Fishing	4,462	0.2	423	0.4	454	0.3	877	0.3	39	0.9	124	1.2	47	0.2	38	0.3
Precision Prod, Craft, Repair	235,483	11.1	15,755	14.8	12,559	7.6	28,314	10.4	743	16.6	1796	17.1	1072	3.5	1243	10.7
Operators, Fabricators, Laborers	265,547	12.5	15,948	15.0	14,792	8.9	30,740	11.3	602	13.5	1,672	15.9	1,532	5.0	1,239	10.7
Class of Workers																
Private for Profit	1,567,312	73.9	76,860	72.1	116,296	70.0	193,156	70.8	3,180	71.2	7,573	72.1	21,802	70.8	8,772	75.5
Private, Not for Profit	110,905	5.2	5,500	5.2	10,047	6.0	15,547	5.7	256	5.7	464	4.4	2,002	6.5	445	3.8
Local Government	130,583	6.2	7,785	7.3	11,458	6.9	19,243	7.1	324	7.3	924	8.8	1,858	6.0	854	7.3
State Government	89,550	4.2	6,102	5.7	8,178	4.9	14,280	5.2	340	7.6	496	4.7	1,135	3.7	786	6.8
Federal Government	38,003	1.8	1,712	1.6	3,107	1.9	4,819	1.8	23	0.5	61	0.6	321	1.0	129	1.1
Self-Employed	127,471	6.0	3,702	3.5	10,136	6.1	13,838	5.1	196	4.4	744	7.1	2,194	7.1	767	6.6
Unpaid Family Workers	5,494	0.3	308	0.3	484	0.3	792	0.3	6	0.1	12	0.1	124	0.4	24	0.2
Median Household Income 1999 ($)	44,761	NA	48,632	NA	63,831	NA	57,661	NA	34,888	NA	35,510	NA	81,767	NA	62,369	NA
Poverty Status	628,385	13.50	24,660	10.20	25,166	7.10	49,826	8.40	2,129	19.20	3,861	16.10	2,372	3.70	1,465	4.80

Source: U.S. Census Bureau (2000).

*Includes Brazoria County Tract 6619; Fort Bend County Tracts 6746, 6755, and 6756.

+2000 Census Bureau information was used because 2010 Census data is not yet available for this type of information.

same pattern is shown for the cities examined. Richmond and Rosenberg, with a relatively higher percentage of home-county workers, have median travel times of 26.7 and 27.0 minutes, respectively. In Sugar Land, where only 35.5 percent of residents work in their home county, the median travel time to work is 29.6 minutes.

Occupation

As compared with the HGB CMSA, the rest of the study area workers are more likely to be employed in technical/sales/administrative support and less likely to be employed as operators, fabricators, and laborers.

For the HGB CMSA, the greatest number of workers (35.2 percent) are employed in managerial and professional positions. This occupational category is followed by service occupations (27.3 percent) and technical, sales, and administration support occupations (13.6 percent). Operators, fabricators, and laborers account for 12.5 percent of workers, while precision production, craft, and repair professions account for 11.1 percent of workers.

In the study area CTs, the greatest number of workers (41.2 percent) are employed in managerial and professional positions. This occupational category is followed by service occupations (24.2 percent of workers) and technical, sales, and administrative support occupations (12.9 percent). Precision production, craft and repair professions, and operators, fabricators, and laborer occupations each employ 10.7 percent of the workforce. The two-county Brazoria/Fort Bend region reflects generally the same occupational characteristics as the more limited study area tracts, although Fort Bend County shows a slightly higher percentage of managerial professions (44.4 percent) and Brazoria County has a greater percentage of operators, fabricators and laborers and precision production, and craft occupations, at 15.0 and 14.8 percent, respectively.

Examining occupational distributions for area cities, Sugar Land is preponderantly oriented toward managerial and professional occupations (56.8 percent) and service occupations (27.1 percent). Compared with the study area tracts, Richmond and Rosenberg have a greater percentage of service workers and technical, sales, and administrative support workers.

Class of Worker

Private, for-profit enterprises employ 73.9 percent of HGB CMSA workers; this percentage is roughly the same for the two-county region, for the various cities in the area, and for the study area. Also, in the HGB CMSA, the two-county region, the cities in the area, and the study area, state and local governments employ an average of 12.5 percent of workers.

Median Household Income

In 1999, median household income for the HGB CMSA was $44,761. Median household incomes for Brazoria and Fort Bend counties were higher, at $48,632 and $63,831, respectively. Median household income for the combined two-county

area was $57,661, which is 28.8 percent higher than the HGB CMSA income. Study area median household income was 39.3 percent higher than for the HGB CMSA at $62,369.

In contrast, the area cities of Richmond and Rosenberg had median household incomes below that of the HGB CMSA, at $34,888 and $35,510, respectively. On the other hand, the City of Sugar Land has a median household income almost double that for the HGB CMSA at $81,767.

Poverty Status

The percent of residents with poverty-level income corresponds to the differences in household incomes. The study area has a very low percentage of poverty status persons (at 4.8 percent), when compared with the HGB CMSA (at 13.5 percent), and Brazoria and Fort Bend counties, at 10.2 and 7.1 percent, respectively. The cities of Richmond and Rosenberg have higher percentages of poverty status persons, at 19.2 and 16.1 percent, respectively. The City of Sugar Land has a smaller proportion of poverty status persons than the study area at 3.7 percent.

Summary

Compared with the population in the HGB CMSA, the study area population in 2000 had a greater tendency to work outside their home counties, and had longer commute times to work. In both the study area and the HGB CMSA, managerial and professional positions are the most dominant occupations for the workforce. However, the study area has a slightly greater proportion of workers (than the HGB CMSA) who are employed in these occupations. The study area workforce and that of the HGB CMSA are roughly equal in their tendency to be employed in service occupations, technical, sales, and administrative support occupations. The class of workers in the study area is similarly structured as in the HGB CMSA. In both cases, private, for-profit workers are the dominant grouping, with roughly two-thirds of all workers in this category. State and local government workers are the second greatest grouping in both cases, representing roughly 11 percent in both cases. The study area populations have relatively higher median incomes and lower levels of poverty than the population of the HGB CMSA.

3.4.1.2 Leading Economic Sectors

Regional

Table 3-9 provides an area economic profile regarding the leading economic sectors for the years 2000, 2002, 2004, 2006, and 2008. Since 2000, Brazoria County is experiencing growth within the information; finance and insurance; and real estate and rental and leasing as well as educational services; health care and social assistance; and accommodation and food services. Fort Bend County is experiencing growth in educational; heath care and social assistance; and accommodation and food services as well as finance and insurance; professional, scientific and technical; and administrative and support and waste management and remediation services. Within Brazoria County, finance and insurance services showed the most growth between 2000 and 2008, a 67.49 percent increase, with the addition of 567

TABLE 3-9
COUNTY ESTABLISHMENTS AND EMPLOYEES
BRAZORIA AND FORT BEND COUNTIES

County/Industry	Total Number of Establishments						Number of Employees					
	Year					2000–2008 % Change	Year					2000–2008 % Change
	2000	2002	2004	2006	2008		2000	2002	2004	2006	2008	
Brazoria County												
Forestry, Fishing & Agric. Support	10	8	10	7	6	-40.00	20-99	30	51	20-99	48	-
Mining	32	33	24	28	35	9.38	659	663	542	590	776	17.75
Utilities	28	29	20	18	14	-50.00	238	275	244	203	NA	-
Construction	382	371	381	396	403	5.50	9,515	11,685	10,174	12,397	13268	39.44
Manufacturing	224	221	212	216	220	-1.79	15,005	12,501	12,526	12,650	13369	-10.90
Wholesale Trade	215	207	197	206	211	-1.86	2,531	2,494	1,650	2,099	2243	-11.38
Retail Trade	652	683	683	683	764	17.18	9,089	9,603	10,783	11,502	12613	38.77
Transportation & Warehousing	123	132	137	147	163	32.52	1,453	1,411	2,230	2,230	2848	96.01
Information	46	54	63	66	67	45.65	549	586	558	559	1358	147.36
Finance and Insurance	203	215	241	282	340	67.49	1,413	1,401	1,664	1,858	1980	40.13
Real Estate, Rental & Leasing	173	208	231	241	267	54.34	1,314	1,517	1,543	1,618	1468	11.72
Professional, Sci, & Tech. Services	302	348	358	396	414	37.09	1,607	1,959	1,970	2,295	2246	39.76
Mgmt. of Companies & Enterprise	-	10	13	20	14	-	-	209	229	237	239	-
Admin, Support, Waste Mgt, Remediation Services	182	166	168	194	191	4.95	3,439	3,123	4,474	4,042	3361	-2.27
Educational Services	-	32	45	51	65	-	-	251	503	517	575	-
Health Care & Social Services	-	391	421	476	536	-	-	5,105	5,708	5,890	6914	-
Arts, Entertainment & Recreation	-	63	63	75	76	-	-	567	875	940	1013	-
Accommodation & Food Services	-	313	336	364	414	-	-	5,110	5,449	6,600	7642	-
Other Services	-	508	521	499	497	-	-	3,275	3,606	3,565	3897	-
Unclassified	53	26	17	16	7	-86.79	77	21	21	0-19	25	-67.53
Totals*	3,837	4,018	4,141	4,381	4,704	22.6	60,876	61,786	64,800	69,839	76,051	24.93

TABLE 3-9, CONT'D

County/Industry	Total Number of Establishments						Number of Employees					
	Year					2000–2008 % Change	Year					2000–2008 % Change
	2000	2002	2004	2006	2008		2000	2002	2004	2006	2008	
Fort Bend County												
Agric. Serv., Forestry & Fishing	10	13	8	6	9	-10.00	20-99	20-99	55	61	45	-
Mining	68	65	71	79	82	20.59	999	512	1,096	1,429	1827	82.88
Utilities	16	39	39	31	19	18.75	1,000–2,499	1,357	1,535	1,104	NA	-
Construction	473	509	565	608	677	43.13	5,237	6,140	6,252	7,156	7583	44.80
Manufacturing	313	301	317	321	330	5.43	11,542	10,916	10,451	11,980	12997	12.61
Wholesale Trade	458	503	512	568	609	32.97	4,285	4,873	5,367	5,491	6091	42.15
Retail Trade	1,008	1,059	1,087	1,098	1224	21.43	14,781	15,722	16,517	17,820	20315	37.44
Transportation & Warehousing	87	83	92	117	136	56.32	479	497	1,807	1,999	2515	425.05
Information	95	99	113	110	100	5.26	2,156	1,798	1,419	1,290	1189	-44.85
Finance and Insurance	359	431	456	560	623	73.54	2,061	2,603	3,144	3,460	3985	93.35
Real Estate, Rental & Leasing	256	290	335	368	397	55.08	1,312	1,406	1,384	1,597	1577	20.20
Professional, Sci, & Tech. Services	742	931	988	1,067	1220	64.42	6,008	6,621	6,620	7,719	6186	2.96
Mgmt. of Companies & Enterprise	-	40	35	54	49	-	-	3,082	4,142	3,316	3293	-
Admin, Support, Waste Mgt, Remediation Services	306	323	360	423	491	60.46	3,656	3,934	4,551	6,087	7544	106.35
Educational Services	69	83	103	118	132	91.30	745	988	1,080	1,184	1381	85.37
Health Care & Social Services	568	672	759	897	1069	88.20	6,646	7,208	8,735	10,695	11741	76.66
Arts, Entertainment & Recreation	64	73	76	78	97	51.56	1,771	1,599	1,713	2,441	2485	40.32
Accommodation & Food Services	396	444	522	595	696	75.76	7,814	8,263	9,873	12,019	13891	77.77
Other Services	570	617	623	662	710	24.56	4,782	4,941	4,869	5,169	5706	19.32
Unclassified	109	33	44	30	25	-77.06	175	0-19	39	18	NA	-
Totals*	6,008	6,615	7,105	7,790	8,695	44.72	78,648	82,953	90,649	102,035	112,606	43.18

Source: U.S. Census Bureau (2011).

*Some information withheld to avoid disclosing data for individual companies

Note: NA is Not Available

Note: 2010 data is not yet available for the information provided in this table; therefore, 2008 data is the last year provided.

establishments (40.1 percent increase). Real estate and rental and leasing services grew by 53.3 percent. There was a 50.0 percent decrease in utilities and a 40 percent decrease in agriculture, forestry, fishing, and hunting. Manufacturing and construction had the highest number of employees in 2000 and maintain the highest number of employees in 2008 with 13,369 and 13,268, respectively, in 2008. Within Fort Bend County, educational services and health care and social assistance showed the most growth 91.3 and 88.2 percent, respectively. Accommodation and food services as well as finance and insurance services also showed growth with 78.7 and 73.5 percent, respectively. Retail trade and Manufacturing services had the highest number of employees in 2000 and maintained the highest number of employees in 2008 with 20,315 and 12,997, respectively. There was a 10 percent reduction in agriculture, forestry, fishing and hunting in Fort Bend County. Also, the number of employees in field of information services decreased by 44.9 percent.

Construction sector activity is further illustrated in Table 3-10 and shows the number of housing units permitted from 1996 to 2008. During that period of time, over almost 45,000 new housing units were permitted in Brazoria and Fort Bend counties. Of those, 19,611 were permitted in the Brazoria County, and 25,341 were permitted in Fort Bend County.

Study Area

In the study area, the major businesses appear to be community retail and services, based on a windshield survey. Residential construction has also been heavy in the northernmost portion of the study area.

3.4.1.3 Labor Force and Employment

Table 3-11 contains data for the decade on the region's labor force estimates, employment, and unemployment rates, as compared with the same figures for the entire state.

The Houston metropolitan area constitutes a considerable portion of the state's labor force, with over 20 percent of all workers in the state. Generally, trends in the Houston area are reflected in statewide employment and labor force statistics.

The metropolitan labor force increased between 2000 and 2010 by 576,444 workers, or 27.8 percent. Unemployment has increased from 4.1 percent in 2000 to 8.5 percent in 2010. These figures are comparable to activity throughout the state, where unemployment in 2000 was 4.2 percent and 8.2 percent in 2010. Unemployment in the metropolitan area is slightly higher than statewide unemployment.

Of the two counties in the study area, Fort Bend County's labor force grew at a slightly more accelerated pace than Brazoria County, 48.9 percent compared to 40.1 percent, respectively, over the 2000–2010 period. The two area cities experienced increases in labor force; however, the City of Rosenberg's labor force only increase slightly by 0.9 percent, while the City of Sugar Land's labor force increased by 98.6 percent. There were also differences between area counties in terms of unemployment rates. Brazoria County has generally tended to have higher unemployment rates than the Houston metropolitan area, while Fort Bend County has experienced lower rates than the region as a whole. The 2010

TABLE 3-10
NEW PRIVATELY OWNED HOUSING UNITS
STUDY AREA COUNTIES
2000–2010

	Units							
Units per Structure	**2000**	**2002**	**2004**	**2006**	**2008**	**2010**	**2000–2010 New Structures (Number)**	**2010 % of Total within County**
Brazoria County								
1 Unit	1,903	2,738	3,288	3,287	1,977	1,647	14,840	99.5
2 Units	2	0	0	4	0	0	6	0.0
3 and 4 Units	0	0	28	0	0	0	28	0.0
5 Units and More	180	343	1,051	298	150	9	2,031	0.5
Total Units	2,085	3,081	4,367	3,589	2,127	1,656	16,905	
Fort Bend County								
1 Unit	1,063	1,130	3,858	7,910	5,689	4,724	23,374	99.7
2 Units	0	0	2	2	6	0	10	0.0
3 and 4 Units	0	0	0	155	0	0	155	0.0
5 Units and More	250	0	292	729	192	16	1,479	0.13
Total Units	1,313	1,130	4,152	8,796	5,887	4,740	26,018	
Total for Both Counties	3,398	4,211	8,519	12,385	8,014	12,792	49,319	

Source: U.S. Census Bureau (2010).

TABLE 3-11
REGIONAL CIVILIAN LABOR FORCE AND EMPLOYMENT ESTIMATES
ANNUAL AVERAGE, 2000–2010

	Year											2000–2010 Change	
Factor Area	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**Number**	**%**
Civilian Labor Force													
Texas	10,324,527	10,462,712	10,803,187	10,964,756	11,051,912	11,170,574	11,348,147	11,474,987	11,701,585	11,906549	12,136,384	1,811,857	17.6
Houston-Sugar Land-Baytown MSA	2,163,502	2,201,442	2,519,885	2,557,767	2,577,349	2,613,896	2,674,420	2,723,348	2,781,315	2,840,477	2,895,737	732,235	33.8
Brazoria County	106,312	106,660	127,036	129,859	131,993	134,096	134,940	138,430	141,773	146,087	148,943	42,631	40.1
Fort Bend County	189,472	192,818	206,947	217,182	225,687	235,978	244,977	253,919	259,044	276,683	282,100	92,628	48.9
Both Counties	295,784	299,478	333,983	347,041	357,680	370,074	379,917	392,349	400,817	422,770	431,043	135,259	45.7
City of Rosenberg	15,973	16,262	NA	NA	NA	14,350	14,719	15,297	15,639	15,761	16,113	140	0.9
City of Sugar Land	21,306	21,674	NA	NA	NA	39,650	40,869	40,937	41,627	41,487	42,302	20,996	98.6
Employment													
Texas	9,887,039	9,955,270	10,115,299	10,228,640	10,385,318	10,568,414	10,787,397	10,972,152	11,126,436	11,006,179	11,141,903	1,254,864	12.7
Houston-Sugar Land-Baytown MSA	2,074,164	2,107,065	2,367,554	2,385,219	2,417,074	2,468,010	2,540,012	2,606,101	2,646,966	2,625,636	2,650,608	576,444	27.8
Brazoria County	99,685	100,336	118,938	120,353	122,839	126,408	128,157	132,264	134,338	134,282	135,559	35,874	36.0
Fort Bend County	183,995	186,914	196,216	203,879	213,190	223,641	233,293	243,532	247,350	256,987	259,430	75,435	41.0
Both Counties	283,680	287,250	315,154	333,543	336,029	350,049	361,450	375,796	381,688	391,269	394,989	111,309	39.2
City of Rosenberg	15,391	15,635	NA	NA	NA	13,630	14,039	14,689	14,919	14,634	14,773	-618	-4.0
City of Sugar Land	20,797	21,126	NA	NA	NA	37,924	39,253	39,530	40,149	39,220	39,593	18,796	90.4
Unemployment Rate (Percent)													
Texas	4.2	4.9	6.4	6.7	6.0	5.4	4.9	4.4	4.9	7.6	8.2	NA	NA
Houston MSA	4.1	4.3	6.0	6.7	6.2	5.6	5.0	4.3	4.8	7.6	8.5	NA	NA
Brazoria County	6.2	5.9	6.4	7.3	6.9	5.7	5.0	4.5	5.2	8.1	9.0	NA	NA
Fort Bend County	2.9	3.1	5.2	6.1	5.5	5.2	4.8	4.1	4.5	7.1	8.0	NA	NA
Both Counties	9	9	5.6	5.4	6.1	5.4	4.9	4.2	4.8			NA	NA
City of Rosenberg	3.6	3.9	NA	NA	NA	5.0	4.6	4.0	4.6	7.2	8.3	NA	NA
City of Sugar Land	2.4	2.5	NA	NA	NA	4.4	0.0	3.4	3.6	5.5	6.4	NA	NA

Source: Texas Workforce Commission (2011).

Note: Data for City of Richmond was unavailable for years 2000–2010.

unemployment rate for Brazoria County was 9.0 percent, while Fort Bend's unemployment rate was 8.0 percent. There is considerable variation among area cities as well; in 2010, unemployment for Rosenberg and Sugar Land was 8.3 and 6.4 percent, respectively.

3.4.1.4 Personal Income

Personal income for the region and the state are shown in Table 3-12. Personal income in the metropolitan area has consistently been approximately 15–25 percent higher than that of the state as a whole. Brazoria County's per capita income has stayed fairly consistent with the state since 1970. Fort Bend County's per capita income has exceeded the state since 1980. Brazoria County has had lower per capita income that the metropolitan area since 2007; however, Fort Bend County has had per capita incomes greater than metropolitan area since 1980.

TABLE 3-12
PERSONAL INCOME IN STUDY AREA REGION

Factor/Location	1970	1980	1990	2000	2009/2010*
Total Personal Income ($000)					
Texas	40,819,997	141,658,500	297,146,169	593,139,424	952,338,721
HSBMSA	9,236,168	38,910,447	77,166,397	161,397,579	273,246,563
Brazoria County	406,011	1,842,833	3,341,252	6,573,637	11,602,475
Fort Bend County	167,984	1,634,128	4,506,056	12,088,185	25,503,482
Population Estimates					
Texas	11,236,772	14,338,208	17,044,605	20,946,049	25,257,114
HSBMSA	2,213,853	3,184,357	3,792,007	4,739,625	5,867,489
Brazoria County	108,854	170,849	192,581	243,140	309,208
Fort Bend County	52,894	133,267	228,359	358,758	556,870
Per Capita Personal Income ($)					
Texas	3,633	9,880	17,421	28,317	37,706
HSBMSA	4,172	12,219	20,350	34,053	46,570
Brazoria County	3,730	10,786	17,344	27,038	37,523
Fort Bend County	3,176	12,262	19,747	33,695	45,798
Per Capita Personal Income as Percent of National Average					
Texas	100.00	100.00	100.00	100.00	94.0
HSBMSA	113.90	123.67	116.81	120.26	117.0
Brazoria County	102.67	109.17	99.56	95.48	97
Fort Bend County	87.42	124.11	113.35	118.99	116

Source: U.S. Department of Commerce, Bureau of Economic Analysis (2011).
*Houston-Sugar Land-Baytown Metropolitan Statistical Area (HSBMSA), Brazoria and Fort Bend County data was not available for 2010; therefore, 2009 data is presented.

3.4.1.5 Financial Conditions

Table 3-13 shows tax rate information for the major governmental bodies in the vicinity of the study area. Neither the Brazoria County Central Appraisal District nor the Fort Bend County Central Appraisal District had maps to indicate all the taxing entities within the study area, but the major entities were identified from examination of a sample of property tax

records in the area. In addition to current taxing entities, it is possible that nearby entities, such as the City of Sugar Land and the City of Richmond, may be affected by the proposed project as these cities experience expansion in the vicinity of the roadway.

3.5 PEDESTRIANS AND BICYCLISTS

A Regional Bicycle Plan was approved by the H-GAC in April 1996 and revisions and updates have been made since that time. Some of the updates and revisions were made as part of the 2002–2004 Transportation Improvement Program (TIP), in the 2006–2008 TIP, 2011–2014 TIP and H-GAC's 2035 RTP Update. No existing or proposed bike facilities fall within the study area.

TABLE 3-13
TAX RATE FOR MAJOR TAXING JURISDICTIONS
IN STUDY AREA REGION

Jurisdiction	2010 Tax Rate ($)
Brazoria County	
Brazoria County	0.40
Brazoria Co. Road & Bridge	0.06
Alvin ISD	1.30
Alvin Community College	0.20
Iowa Colony Drainage District	0.19
Fort Bend County	
Fort Bend County	0.48
Fort Bend Drainage District	0.02
City of Richmond	0.79
City of Rosenberg	0.50
City of Sugar Land	0.30
Fort Bend ISD	1.34
Lamar CISD	1.36
Needville ISD	1.52
Wharton County Jr. College	0.14

Source: Brazoria County Appraisal District (2011); Fort Bend County Appraisal District (2011).

3.6 AIR QUALITY

Air pollution may contribute to adverse human health effects and ecosystem degradation. Motor vehicles, industries, construction equipment, and some commercial operations are among the sources of air pollution in the Houston area. The main air pollutants emitted from motor vehicles are volatile organic compounds (VOCs), nitrogen oxides (NO_x), carbon monoxide (CO), carbon dioxide, particulate matter (PM), and a class of compounds called mobile source air toxics (MSATs). VOCs and NO_x can react in the air in sunlight to form ground-level O_3. Because the reactions take place over several hours, maximum concentrations of O_3 are often far downwind of the precursor sources. Thus, O_3 is a regional problem and not a local condition.

3.6.1 National Ambient Air Quality Standards

The U.S. Environmental Protection Agency (EPA) sets National Ambient Air Quality Standards (NAAQS) for seven air pollutants to protect public health and the environment, with an adequate margin of safety. NAAQS exist for the seven pollutants: CO, O_3, nitrogen dioxide (NO_2), sulfur dioxide (SO_2), PM for both 10 and 2.5 microns and less (PM_{10} and $PM_{2.5}$), and lead (Pb). The Clean Air Act Amendments (CAAA) of 1990 establishes specific milestones toward attaining the NAAQS, depending on the severity of the air pollution problem in the region.

VOCs in motor vehicle emissions are created by incomplete combustion. Some of these VOCs contribute to O_3 and smog formation, while others, such as benzene and formaldehyde, are toxic or carcinogenic. Trucks and older cars emit much more VOCs than newer cars.

NO_x is created inside the combustion chambers of motor vehicles when, under high heat and pressure, nitrogen molecules in air are split into reactive nitrogen atoms, which then combine with oxygen. NO_x also reacts with oxygen and organic compounds in the atmosphere to form O_3 and smog. Motor vehicles produce the least emissions of NO_x per mile between 20 and 30 miles per hour (mph). NO_x emissions per mile increase as vehicles go slower or faster, so simply increasing or decreasing average traffic speed can increase NO_x emissions.

CO is a very reactive gas that can cause asphyxiation. Because of its high reactivity, it does not persist in the air long after it is emitted, and therefore, CO is a local problem where it occurs. Current CO emissions are estimated for 2017 (the year construction is estimated to be completed) and 2035 (the horizon year for project planning) for this project with a computer model that is approved by the FHWA as discussed in Section 4.6.2. Estimated CO levels along SH 99 are below the national standard.

PM consists of tiny particles that are emitted by vehicle engines (especially the diesel engines of trucks), brake pads, tires, and other moving parts of motor vehicles. These particles contribute to smog and haze, and are dangerous to human health, especially to people with respiratory conditions. The EPA provides health criteria for particles smaller than 10 microns (about one-seventh the width of a human hair) and for particles smaller than 2.5 microns.

The NAAQS for the seven pollutants are listed in Table 3-14. The EPA delegated authority for monitoring and enforcing air quality regulations in Texas to the Texas Commission on Environmental Quality (TCEQ) Office of Air Quality. The TCEQ may adopt other, more stringent, air quality standards than those of the EPA; however, the TCEQ observes the same air quality standards as the EPA.

Motor vehicles are the primary source of air pollution emissions associated with the proposed project. The impact of such emissions varies with the region's total CO emissions from motor vehicles, weather conditions, and topography of the region. In addition to CO, motor vehicles also produce VOCs and NO_X, which can react under certain conditions to form O_3. Determining the cause of O_3 through modeling requires long-term meteorological data and detailed area-wide emission rates for all potential sources (industry, business, and transportation).

TABLE 3-14
NATIONAL AMBIENT AIR QUALITY STANDARDS

Pollutant	Primary Standard (Public Health)		Secondary Standard (Public Welfare)	
	Level	Averaging Times	Level	Averaging Times
Nitrogen Dioxide	100 ppb	1-hour(1)	No secondary standard	
	53 ppb	Annual (Arithmetic Mean)(2)	Same as primary standard	
Carbon Monoxide	35 ppm	1-hour(3)	No secondary standard	
	9 ppm	8-hour(3)		
Particulate Matter 10 microns or smaller (PM_{10})	150 µg/m^3	24-hour(4)	Same as Primary Standard	
Particular Matter 2.5 microns or smaller ($PM_{2.5}$)	15 µg/m^3	Annual (Arithmetic Mean)(5)	Same as Primary Standard	
	35 µg/m^3	24-hour(6)	Same as Primary Standard	
Ozone	0.075 ppm (2008 Std)	8-hour(7)	Same as Primary Standard	
	0.08 ppm (1997 Std)	8-hour(8)		
	0.12 ppm	1-hour(9)		
Sulfur Dioxide	75 ppb	1-hour(10)	0.5 ppm	3-hour(3)
Lead	0.15 µg/m^3	Rolling 3-Month Average(11)	Same as primary standard	

Source: 40 CFR 50.

ppb = parts per billion ppm = parts per million; µg/m^3 = micrograms per cubic meter

(1) The 1-hour primary standard is met when the 3-year average of the annual 98th percentile of the daily maximum 1-hour average concentration is less than or equal to 100 ppb.

(2) The annual primary standard is met when the annual average concentration in a calendar year is less than or equal to 53 ppb.

(3) Not to be exceeded more than once per calendar year.

(4) Not to be exceeded more than once per year on average over 3 years.

(5) To attain this standard, the 3-year average of the weighted annual mean $PM_{2.5}$ concentrations from single or multiple community-oriented monitors must not exceed 15.0 µg/m^3.

(6) To attain this standard, the 3-year average of the 98th percentile of 24-hour concentrations at each population-oriented monitor within an area must not exceed 35 µg/m^3 (effective December 17, 2006).

(7) To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.075 ppm (effective May 27, 2008).

(8) To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.08 ppm.

(9) (a) The standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is less than or equal to 1; (b) As of June 15, 2005, the EPA revoked the 1-hour ozone standard in all areas except the fourteen 8-hour ozone nonattainment Early Action Compact Areas. On April 15, 2009, the EPA revoked the 1-hour ozone standard in the remaining Early Action Compact areas.

(10) The 1-hour primary standard is met at an ambient air quality monitoring site when the 3-year average of the annual (99th percentile) of the daily maximum 1-hour average concentrations is less than or equal to 75 ppb. Final rule signed June 2, 2010. The 1971 annual and 24-hour SO2 standards were revoked in that same rulemaking. However, these standards remain in effect until 1 year after an area is designated for the 2010 standard, except in areas designated nonattainment for the 1971 standards, where the 1971 standards remain in effect until implementation plans to attain or maintain the 2010 standard are approved.

(11) Not to be exceeded in a calendar quarter. Final rule signed October 15, 2008. The 1978 lead standard (1.5 µg/m^3 as a quarterly average) remains in effect until 1 year after an area is designated for the 2008 standard, except that in areas designated nonattainment for the 1978 standard, the 1978 standard remains in effect until implementation plans to attain or maintain the 2008 standard are approved.

The EPA designates the status of a county's ambient air with respect to compliance to the NAAQS. The designations are as follows:

- Attainment – meets or is better than requirements
- Nonattainment – did not meet requirements
- Unclassifiable – cannot be classified

This proposed project is located within Brazoria and Fort Bend counties that are part of the HGB and have been designated by the EPA as a "severe" nonattainment area for O_3; therefore, the transportation conformity rule does apply.

The EPA regulations require that a nonattainment area demonstrate that its RTP and TIP conform to the intent of the State Implementation Plan (SIP) to attain the 8-hour O_3 standard by the year 2019. Under the regulations, added capacity projects may advance to construction only if they are part of the RTP and TIP, which has been determined to conform to the SIP. The proposed SH 99 Segment C is included in the H-GAC 2035 RTP Update, approved on January 25, 2011, and Fiscal Year (FY) 2011–2014 TIP, as amended and proposed by H-GAC. The RTP and TIP were found to conform to the SIP on July 21, 2010.

Changes in modeled parameters between the 2025 RTP and the 2035 RTP Update (such as traffic volumes, population, employment, number of households, and vehicle miles traveled [VMT]) have been evaluated to determine whether any additional analysis is warranted before the FHWA takes final environmental action. This evaluation confirmed that the changes in the modeled parameters were minor, and therefore, no additional analysis is warranted. The analysis of 2025–2035 RTP Update modeled parameters can be found in the Administrative Record.

Existing background CO concentrations, attributable to emissions in the general community and to CO transported into that community, for the vicinity of the project area are estimated to be 4.5 and 2.8 parts per million (ppm) for the existing one-hour and eight-hour concentrations, respectively. These estimated background CO concentrations were obtained from TxDOT's 2006 *Air Quality Guidelines*. TCEQ has several Continuous Air Monitoring Stations (CAMS) located throughout the state that monitor air quality in Texas. These sites measure different parameters such as, but not limited to, CO, NO_x, NO_2, and O_3. The closest stations to the project area that measure CO are CAMS C35 and C403, which are located on Durant Street in Deer Park and Clinton Drive in Houston, respectively. For the month of December 2009, these stations measured an average 0.20 and 0.30 ppm, respectively, for existing 1-hour CO concentrations, which are below the NAAQS and the 4.5 ppm for 1-hour background concentrations obtained from TxDOT's 2006 *Air Quality Guidelines*.

3.6.2 Air Toxics

3.6.2.1 Introduction

Controlling air toxic emissions became a national priority with the passage of the CAAA, whereby Congress mandated that the EPA regulate 188 air toxics, also known as hazardous air pollutants (HAPs). The EPA has assessed this expansive list in their latest rule on the Control of Hazardous Air Pollutants from Mobile Sources (*Federal Register* [FR], Vol. 72, No. 37, page 8430, February 26, 2007) and identified a group of 93 compounds emitted from mobile sources that are listed in their Integrated Risk Information System (IRIS) (http://www.epa.gov/ncea/iris/index.html). In addition, EPA identified seven compounds with significant contributions from mobile sources that are among the national and regional-scale cancer risk drivers from their 1999 National Air Toxics Assessment (http://www.epa.gov/ttn/atw/nata1999/). These are:

- *acrolein,*
- *benzene,*
- *1,3-butadiene,*
- *diesel particulate matter plus diesel exhaust organic gases (diesel PM),*
- *formaldehyde,*
- *naphthalene,*
- *and polycyclic organic matter*.

While FHWA considers these the priority MSATs, the list is subject to change and may be adjusted in consideration of future EPA rules. Air toxics analysis is a continuing area of research. While much work has been done to assess the overall health risk of air toxics, many questions remain unanswered. In particular, the tools and techniques for assessing project-specific health outcomes as a result of lifetime MSATs exposure remain limited. These limitations impede the ability to evaluate how the potential health risks posed by MSAT exposure should be factored into project-level decision-making within the context of NEPA.

Nonetheless, air toxics concerns continue to be raised on highway projects during the NEPA process. Even as the science emerges, we are duly expected by the public and other agencies to address MSAT impacts in our environmental documents. The FHWA, EPA, the Health Effects Institute, and others have funded and conducted research studies to try to more clearly define potential risks from MSAT emissions associated with highway projects. The FHWA will continue to monitor the developing research in this emerging field.

3.6.2.2 Health Effects of Air Toxics

In FHWA's view, information is incomplete or unavailable to credibly predict the project-specific health impacts due to changes in MSAT emissions associated with a proposed set of highway alternatives. The outcome of such an assessment, adverse or not, would be influenced more by the uncertainty introduced into the process through assumption and

speculation rather than any genuine insight into the actual health impacts directly attributable to MSAT exposure associated with a proposed action.

The EPA is responsible for protecting the public health and welfare from any known or anticipated effect of an air pollutant. They are the lead authority for administering the CAAA and have specific statutory obligations with respect to HAPs and MSAT. The EPA is in the continual process of assessing human health effects, exposures, and risks posed by air pollutants. They maintain IRIS, which is "a compilation of electronic reports on specific substances found in the environment and their potential to cause human health effects" (EPA, http://www.epa.gov/ncea/iris/index.html). Each report contains assessments of noncancerous and cancerous effects for individual compounds and quantitative estimates of risk levels from lifetime oral and inhalation exposures with uncertainty spanning perhaps an order of magnitude.

Because of the limitations in the methodologies for forecasting health impacts described, any predicted difference in health impacts between alternatives is likely to be much smaller than the uncertainties associated with predicting the impacts. Consequently, the results of such assessments would not be useful to decision makers, who would need to weigh this information against project benefits, such as reducing traffic congestion, accident rates, and fatalities plus improved access for emergency response, which are better suited for quantitative analysis.

3.6.2.3 Monitored Levels of MSATs

The TCEQ and other local entities operate air quality monitors for the criteria pollutants and air toxics. This network of monitors measures the air quality and determines the levels of the various pollutants in the air. However, not all monitors measure for all criteria pollutants and air toxics. The closest air quality monitors to Segment C are 9 miles (CAMS 84), 13 miles (CAMS 410), and 15 miles (CAMS 409) away as shown in Table 3-15. The official data from these monitors are found on the EPA's maintained web site (www.epa.gov/air/data). Not all monitors sample for the same pollutants. Of the monitors in the vicinity of Segment C, only the air toxics 1,3-butadiene and benzene are reported for the more distant monitor locations in Texas City (CAMS 100 and 1022).

Figure 3-1 illustrates a 10-year trend (1998-2008) of 1,3-butadiene and benzene mean concentrations (parts per billion or ppb) at the Texas City monitor locations. The results indicate a general downward trend in emission concentrations at these locations. There are currently no NAAQS established for any of the priority MSATs. Thus, the monitored values cannot be compared to any specific standards at this time.

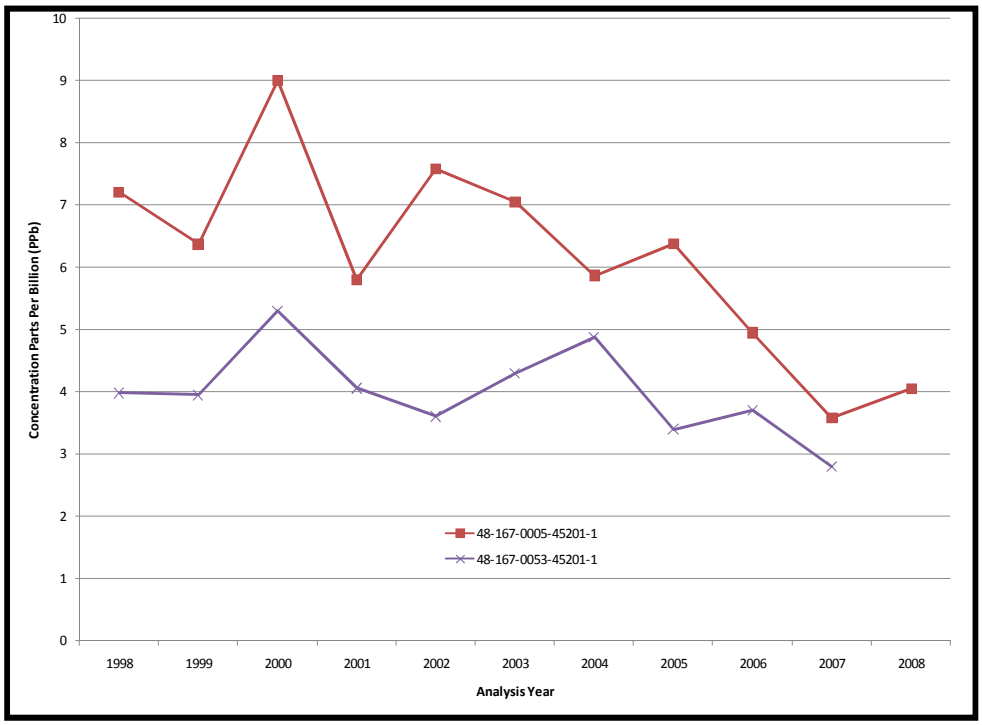
TABLE 3-15
MONITOR LOCATIONS IN THE VICINITY OF SEGMENT C

EPA Monitor ID (TCEQ ID)	Location	Distance from Preferred Alternative	MSATs Monitored
48-039-1004 (CAMS 84)	Brazoria County, Manvel	9 miles	N/A
48-167-0053 (CAMS 100)	Galveston County, Texas City	30 miles	1,3-Butadiene, Benzene
48-201-0051 (CAMS 409)	Harris County, Houston	15 miles	N/A
48-201-0066 (CAMS 410)	Harris County, Houston	13 miles	N/A
48-167-0005 (CAMS 1022)	Galveston County, Texas City	30 miles	1,3-Butadiene, Benzene

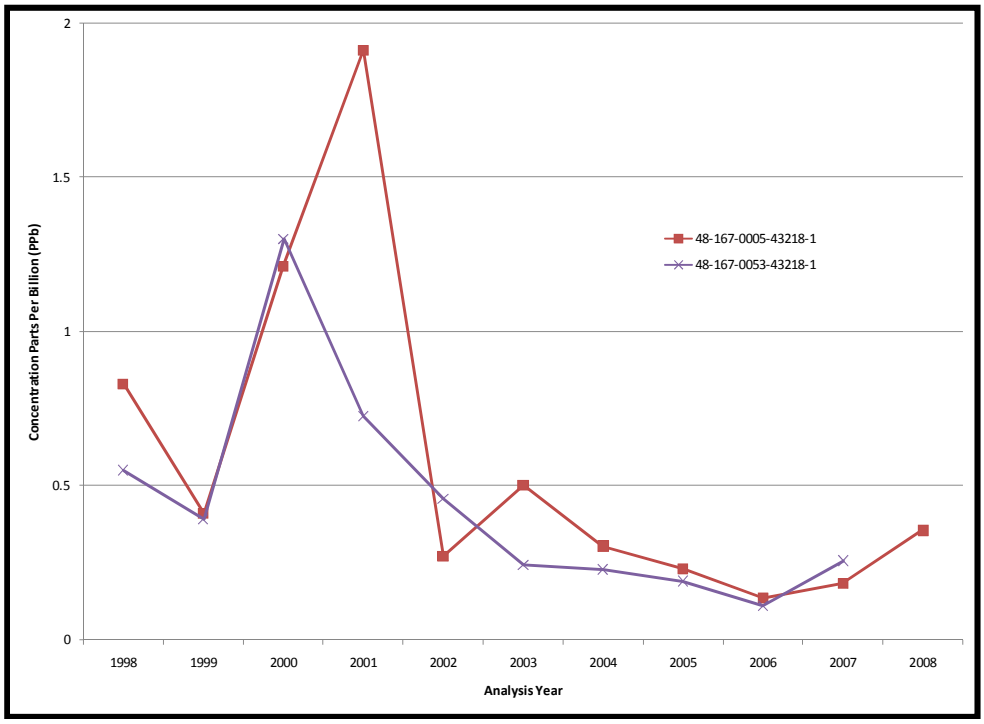
Source: EPA AirData; Study Team (2011).

Readers are cautioned not to infer a qualitative ranking order of geographic areas based on EPA AirData reports. Air pollution levels measured near a particular monitoring site may not be representative of the prevailing air quality of a county or urban area. Pollutants emitted from a particular source may have little impact on the immediate geographic area, and the amount of pollutants emitted does not indicate whether the source is complying with applicable regulations.

Figure 3-1
EPA Monitored Values for Air Toxics in Vicinity of Segment C
(Benzene)



(1,3-Butadiene)



Source: EPA AirData: www.epa.gov/air/data annual mean concentrations in ppb; Study Team (2011).

3.7 EXISTING NOISE ENVIRONMENT

3.7.1 Characteristics of Noise

Sound from highway traffic is generated primarily from a vehicle's tires, engine, and exhaust. It is commonly measured in decibels and is expressed as "dB."

Sound occurs over a wide range of frequencies. However, not all frequencies are detectable by the human ear; therefore, an adjustment is made to the high and low frequencies to approximate the way an average person hears traffic sounds. This adjustment is called A-weighting and is expressed as decibels (dB(A)). Also, because traffic sound levels are never constant due to the changing number, type, and speed of vehicles, a single value is used to represent the average or equivalent sound level and is expressed as "L_{eq}." Table 3-16 compares some common sounds and noise levels for indoor and outdoor situations.

TABLE 3-16
COMMON SOUND NOISE LEVELS

OUTDOOR	dB(A)	INDOOR
Air horn	110	Rock/blues band
Jet flyover at 1,000 feet		Baby crying
Leaf Blower	100	Subway
Gas Weed Eater		Fire alarms
Riding lawn mower	90	Blender
Gas edger		Crowded restaurant
Police whistle	80	Disposal at 3 feet
Air conditioner compressor		Shouting at 3 feet
	70	
		Normal conversation at 3–5 feet
Normal conversation at 3 feet	60	Clothes dryer at 3 feet
Babbling brook		Large business office
Quiet urban (daytime)	50	Refrigerator
Quiet urban (nighttime)	40	Quiet Office, Library
Wilderness	30	
	20	Recording studio
	10	Threshold of hearing

Source: TxDOT (2010).

3.7.2 Existing Noise Levels

Existing noise levels were measured at 14 sites (sites 1–14) within the proposed Grand Parkway Segment C study area in November 2010 and January 2012 using a Bruel & Kjaer 2238D sound level meter. A summary of the ambient noise measurement sites and results is presented in Table 3-17, and the locations are shown on (Exhibit 24). Short-term (15 minutes in duration) noise measurements were made at each of these sites.

TABLE 3-17
AMBIENT NOISE MEASUREMENT DATA
PROPOSED GRAND PARKWAY SEGMENT C

Site	Location	Description	Noise Level (dB(A), L_{eq})
1.	Greatwood Subdivision (near US 59), Fort Bend County	Single-family Residence	68.5
2.	Canyon Gate Subdivision, Fort Bend County	Single-family Residence	57.3
3.	The Retreat Subdivision (south of SH 59), Fort Bend County	Single-family Residence	50.2
4.	Brazos Gardens Subdivision, Fort Bend County	Single-family Residence	56.1
5.	Bridlewood Estates (at west end of Grande Gables Drive)	Single-family Residence	50.8
6.	Bridlewood Estates (at Crabb River Road), Fort Bend County	Single-family Residence	63.0
7.	Bonbrook Subdivision, Fort Bend County	Single-family Residence	47.2
8.	Windham Banks Subdivision, Fort Bend County	Single-family Residence	55.9
9.	FM 762 (west of Oak Lake Village Drive), Fort Bend County	Single-family Residence	68.9
10.	West Brazos Bend, Fort Bend County	Single-family Residence	37.8
11.	Sawmill Road (west of Big Creek), Fort Bend County	Single-family Residence	37.0
12.	CR 53 (east of FM 521), Brazoria County	Single-family Residence	40.8
13.	CR 55/Airline (west of SH 288), Brazoria County	Single-family Residence	44.3
14.	CR 60 (west of SH 288), Brazoria County	Single-family Residence	52.2

Dominant noise sources within the proposed Grand Parkway Segment C study area included traffic on existing roads, various kinds of local activity, and sounds created by animals. Measured noise levels varied from a high L_{eq} of 68.9 dB(A) at Site No. 9, at FM 762 west of Oak Lake Village Drive, to a low L_{eq} of 37.0 dB(A) at Site No. 11, located near Sawmill Road. These measured noise levels characterize the existing (ambient) noise levels within the proposed Grand Parkway Segment C study area and include representative peak-hour traffic conditions in urban areas as well as rural isolated traffic conditions.

In Section 4, Environmental Consequences, predictions of traffic-generated noise using forecasted peak hour traffic volumes are compared with ambient noise levels to assess preliminary impacts resulting from the eight Representative Alternatives. The detailed analysis of the Preferred Alternative is also discussed in Section 4.

3.8 WATER QUALITY

3.8.1 Surface Water Quality

The watersheds within the region of influence of the project are located in the Brazos River Basin in Fort Bend and Brazoria counties. The area consists of undeveloped acreage such as farmlands and wooded areas. Major channels in this area are the Brazos River, Rabbs Bayou, Dry Creek, Big Creek, and Oyster Creek. Major lakes in this area are Lake Worthington and Smithers Lake.

The TCEQ Permanent Rules Chapter 307, Texas Surface Water Quality Standards Subsections 307.2–307.10, April 30, 1997, presents surface water quality standards, which apply to all surface waters in the state. The major surface waters of the state are classified in the Texas Surface Water Quality Standards as "segments" for the purposes of water quality management and designation of site-specific standards.

Two classified segments transverse the study area. The first classified segment is Segment 1202J of the Brazos River Watershed. This segment of the Brazos River starts at a point 330 feet upstream of SH 332 in Brazoria County and continues upstream to the confluence of the Navasota River in Grimes County. The second classified segment is Segment 1110 of the San Jacinto-Brazos Coastal Watershed. This is the Oyster Creek segment, which begins at a point 330 feet upstream of FM 2004 in Brazoria County and continues upstream to the Brazos River Authority (BRA) diversion dam 1.1 miles upstream of SH 6 in Fort Bend County. According to the 2010 TCEQ Texas Surface Water Quality Standards, Segments 1202J and 1110 are reported to have elevated levels of fecal coliform. Segment 1110 is reported to have depressed dissolved oxygen levels, while Segment 1202J is reported to be within a normal range for dissolved oxygen.

Water quality data in the study area are available at two stations of the Surface Water Quality Monitoring Program of the TCEQ. Table 3-18 summarizes the ambient water quality data at these two stations.

Big Creek at Big Creek Road has a limited number of annual observations, which appear to have been made at a range of flow and environmental conditions. The maximum temperature observation during the sample period was 33.1 degrees Celsius (°C) (91.6 degrees Fahrenheit [°F]), approximately 1.9 °C below the criterion of 35 °C (95 °F). Five of the 19 samples for fecal coliform exceed the contact recreation criterion, an improvement since previous observations, and most dissolved oxygen values appear satisfactory.

The data for the Brazos River at US 90A in Richmond are somewhat different and more extensive. The station is on the TCEQ Segment 1202, Brazos River below its confluence with the Navasota River. The dissolved oxygen levels are more uniform than those of Big Creek, reflecting a larger waterbody. The conductivity and dissolved solids values tend to be substantially higher, reflecting a larger number of low-flow samples. The fecal coliform values have a long-term geometric mean that is within the existing contact recreation criterion. At this time, Segment 1202 is not on the 303(d) list. The 303(d) list is named after the relevant section of the federal Clean Water Act (CWA) and is a list of waterbodies that do not meet or are not expected to meet applicable water quality standards.

TABLE 3-18
AMBIENT WATER QUALITY CONDITIONS

Station	Parameter	Storet Code	Unit	Data Period		Number of Samples	Mean [1]	Max	Min	Stdev [2]
				From	To					
ID 11518 Big Creek at Gless/Big Creek Road 12.9 km (8 miles) NE Fairchilds	Water Temperature	00010	deg C	08/24/98	02/19/02	28	21.9	33.1	9.7	6.2
	Conductivity	00094	mmhos/cm	10/20/98	02/19/02	27	534.9	1829	85.7	434.7
	Dissolved Oxygen	00300	mg/L	08/24/98	02/19/02	28	7.2	11.3	2.5	2.7
	pH	00400	std. unit	08/24/98	04/16/02	28	7.6	8.8	7.0	0.5
	Total Suspended Solids	00530	mg/L	08/24/98	04/16/02	27	76.8	743.0	6.0	142.9
	Nitrite + Nitrate	00630	mg/L	09/24/97	12/23/97	2	0.475	0.865	0.085	0.552
	Ortho Phosphorus	00660	mg/L	09/24/97	12/23/97	2	0.324	0.387	0.260	0.090
	Chloride	00940	mg/L	08/24/98	02/19/02	27	78.4	578.5	6.2	123.1
	Fecal Coliform	31616	cfu/dL	08/24/98	02/19/02	19	602.4	>1200	24.0	474.8
ID 11846 Brazos River at US90A in Richmond	Water Temperature	00010	deg C	06/23/99	10/25/07	29	23.6	33.4	10.2	7.9
	Conductivity	00095	mmhos/cm	06/23/99	10/25/07	26	701.2	1170.0	240.0	262.7
	Dissolved Oxygen	00300	mg/L	06/23/99	10/25/07	18	7.8	11.8	1.5	2.5
	pH	00400	std. unit	06/23/99	10/25/07	18	8.0	8.5	7.5	0.3
	Total Dissolved Solids	70300	mg/L	12/19/07	09/20/07	2	371.0	452.0	290.0	114.6
	Biochemical Oxygen Demand	00310	mg/L	01/26/93	09/07/95	15	2.0	6.0	1.0	1.2
	Alkalinity	00410	mg/L	01/26/93	09/08/93	5	138	191	80	48
	Hardness	00900	mg/L	02/12/02	08/06/02	3	176.7	200.0	160.0	20.8
	Ammonia Nitrogen	00608	mg/L	06/23/99	09/25/02	11	0.1	0.4	<0.1	0.1
	Total Kjeldahl Nitrogen	00625	mg/L	01/26/93	09/07/95	15	0.593	1.20	0.30	0.252
	Nitrite + Nitrate	00631	mg/L	06/23/99	09/25/02	13	0.4	1.3	0.1	0.5
	Phosphorus	00665	mg/L	01/26/93	09/07/95	15	0.209	0.81	0.04	0.207
	Ortho Phosphorus	00671	mg/L	06/23/09	10/25/07	14	0.044	0.091	0.010	0.030
	Chloride	00940	mg/L	06/23/99	10/25/07	18	85.5	182.3	27.5	49.0
	Sulfate	00945	mg/L	06/23/99	10/25/07	18	54.9	97.1	27.6	22.8
	Fecal Coliform	31625	cfu/dL	01/26/93	07/31/95	14	121	1100	32	0.46

TABLE 3-18, CONT'D

Station	Parameter	Storet Code	Unit	Data Period		Number of Samples	Mean [1]	Max	Min	Stdev [2]
				From	To					
	Aluminum	01106	mg/L	01/26/93	09/07/95	9	31.1	60	< 10	20.9
	Arsenic	01000	mg/L	08/23/99	02/12/02	5	3.2	4.7	1.2	1.3
	Cadmium	01025	mg/L	08/23/99	02/12/02	7	0.4	1.0	<0.1	0.4
	Chromium	01030	mg/L	08/23/99	02/12/02	7	0.9	1.0	0.8	0.1
	Copper	01040	mg/L	08/23/99	02/12/02	7	3.3	7.4	1.1	2.7
	Iron	01046	mg/L	08/23/99	02/12/02	7	23.5	54.0	10.0	20.9
	Lead	01049	mg/L	08/23/99	02/12/02	4	<1.0	<1.0	<1.0	0
	Nickel	01065	mg/L	01/26/93	06/28/96	11	2.82	< 10	< 1	3.57
	Silver	01075	mg/L	08/23/99	02/12/02	5	0.7	1.0	<0.1	0.5
	Zinc	01090	mg/L	08/23/99	02/12/02	7	21.4	24.0	18.0	2.5

Source: TCEQ (2009).

[1]Geometric mean for Fecal Coliform

[2]Standard deviation of log data for Fecal Coliform

Concentration reported as less than a certain value is assigned that value when calculating mean and standard deviation.

3.8.2 Groundwater

Recognized aquifers in the study area that contain freshwater (i.e., water having not more than 1,000 milligrams per liter [mg/l] total dissolved solids) include the Chicot and Evangeline aquifers (Wesselman, 1972). Quaternary alluvial deposits along the Brazos River may also be a source of fresh groundwater, but no published or open-file information on hydraulic characteristics or use of this water-bearing unit were identified.

The Chicot Aquifer is the shallowest major aquifer of the lower Gulf Coastal Plain, and consists of all strata between ground surface and the top of the Evangeline Aquifer. Wesselman (1972) subdivided the Chicot into upper and lower units in southeastern Fort Bend County based on the occurrence of an intervening clay stratum at a depth of about 200 feet. Sand strata constitutes about 40 to 75 percent of the unit, with the rest consisting of less permeable clays, sandy clays, and muds (Wesselman, 1972). The boundaries of the Chicot Aquifer are not distinct, but the upper Chicot is generally correlated to the Beaumont Formation, and the lower Chicot generally correlated to the Montgomery, Bentley, and Willis formations. Groundwater in the upper Chicot may exist under confined (i.e., artesian) or unconfined (i.e., water table) conditions, while groundwater in the lower part is under confined or leaky confined conditions. The elevation of the base of the Chicot Aquifer is estimated to be about 700 feet below msl at the study area.

The Evangeline Aquifer underlies the Chicot Aquifer and is generally correlated with the Pliocene-age Goliad Formation. The Evangeline Aquifer is estimated to be about 1,850 feet thick beneath the study area with the base level of 1,055 feet and upper level of 1 foot. Sand strata constitute about 33 to 40 percent of the aquifer. Wesselman (1972) also concluded there is hydrologic communication between sands of the Evangeline and sands of the lower Chicot in some areas of eastern Fort Bend County.

Recharge to the Chicot and Evangeline aquifers occurs predominantly by infiltration of precipitation through permeable portions of the aquifers that crop out at the land surface, and by leakage from overlying aquifers. Recharge to the Chicot Aquifer occurs mainly on the outcrops of the Montgomery, Bentley, and Willis formations, in Waller, Austin, and Colorado counties (Gabrysch, 1977). Little or no recharge by precipitation occurs where the outcrop of the Chicot corresponds to the outcrop of the low-permeability upper Beaumont Formation. Accordingly, there is likely little recharge to the Chicot Aquifer by direct precipitation in the study area. However, recharge to the upper Chicot likely occurs by leakage from saturated alluvium deposits where the Brazos River valley is deeply incised into the Beaumont Formation. The Goliad Formation, which comprises most of the Evangeline Aquifer, is overlain by the Willis Formation in the study area and in Austin and Waller counties to the north, so recharge to the Evangeline is presumed to occur mainly by leakage from the overlying Chicot Aquifer (Wesselman, 1972).

According to data supplied by the Texas Water Development Board (TWDB), 6,492 acre-feet of groundwater was pumped from the Gulf Coast Aquifer in the project area in 1960. In 1970, a total of 12,418 acre-feet of groundwater was pumped from this aquifer. The total pumpage increased to 36,780 acre-feet in 1980 and to 59,936 acre-feet in 1990.

According to the 19th Annual Ground Water Report of the Fort Bend Subsidence District (FBSD), the 2008 groundwater pumpage from the regional aquifers within the district totaled 101.7 million gallons per day (mgd) (312 acre-feet), compared with 79.1 mgd (243 acre-feet) in 2007. This is a 29 percent increase in 1 year. In 2008, 76 percent of the total pumpage was used in public supply, 8 percent was used for industrial purposes, and 10 percent was used for agricultural purposes. Total public supply has increased 22 percent since 2007, while industrial use has decreased slightly by 6 percent. Total irrigation use varies considerably from year to year.

In 1990, groundwater constituted 59 percent of the total water demand, and surface water sources constituted 40 percent of the total. Treated effluent, used solely for the irrigation of a golf course, made up nearly 0.5 percent. In 2008, groundwater use made up 65 percent of the total water demand, and surface water use constituted 35 percent of the total water demand. In 2008, the Brazos River was the sole source of surface water within the district's boundaries and is currently used only for industrial and irrigation uses. No treated effluent uses have been reported for the past 2 years.

3.8.2.1 Water Well Review

Well records and published groundwater reports of the TWDB were reviewed to provide information on water wells in the study area. The well records were obtained from TCEQ and TWDB (TCEQ, 2011; TWDB, 2011b).

The results of the water well review indicated that a total of 140water-supply wells lie within the study area. There are 20 public and 11 private water supply wells within ¼ mile of the Preferred Alternative. Seventeen of the 20 public wells are completed in the Chicot Aquifer, and total depths range from 185 to 810 feet below ground surface. Three of the wells are completed in the Evangeline Aquifer and total depths range from 594 to 1,942 feet below ground surface. Eight of 11 private wells are completed in the Chicot Aquifer, and the remainder are completed in the Evangeline Aquifer. Total depths range from 50 to 1,942 feet. Private wells are utilized for domestic, livestock, industrial, or irrigation purposes.

3.9 PERMITS

3.9.1 Waters of the U.S., Including Wetlands

Section 404 of the CWA authorizes the USACE to regulate discharges of dredged or fill material into waters of the U.S., including wetlands. As part of the USACE approval process, the state environmental agency (TCEQ) must certify, pursuant to Section 401 of the CWA, that the discharge of dredged or fill material to be licensed or permitted by the USACE will comply with the applicable state effluent limitations and water quality standards. Placement of dredged of fill material within Waters of the U.S., including wetlands, requires a permit from the USACE under Section 404 and water quality certification from the TCEQ under Section 401. The result of the Section 404 evaluations and potential impacts are discussed in Section 3.10 (Wetlands and Vegetative Communities) and Section 4.9 (Wetlands and Vegetative Communities) of this volume.

Section 402 of the CWA prohibits the discharge of any pollutant to Waters of the U.S. from a point source unless the discharge is authorized by a Texas Pollutant Discharge Elimination System (TPDES) permit. Construction activity is considered a point source discharge. Permit authorization may be given under an Individual Permit or an existing General Permit. Currently, coverage under TPDES permit is required in Texas for construction activity that disturbs 5 or more acres, provided an Notice of Intent (NOI) is filed with the TCEQ and EPA (40 CFR 122); even though the TCEQ has assumed authority for the stormwater program from the EPA as part of TPDES authorization.

The TPDES permit requires the completion of a Storm Water Pollution Prevention Plan (SW3P). The SW3P requirements are designated to allow maximum flexibility when selecting Best Management Practices (BMPs) at the construction site. As part of the SW3P, inspections are required of both stabilized and unstabilized areas in the construction site for evidence of, or the potential for, pollutants entering Waters of the U.S. via stormwater runoff. Summary report to these inspections must be written and retained as part of the SW3P. Once construction has been completed, a Notice of Termination must be filed per permit requirements. Additional coordination with Fort Bend Coty local government relative to stormwater pollution prevention may also be required prior to project construction.

3.9.2 Navigable Waters of the U.S.

The General Bridge Act of 1946 and Section 9 and 10 of the Rivers and Harbors Act of 1899 prohibit the unauthorized obstruction, including bridge construction, or alteration of any navigable water of the U.S. unless the work has been authorized by permit from the U.S. Coast Guard (USCG) and the USACE. As defined in 33 CFR 329.4, "Navigable waters of the U.S. are those waters that are subject to the ebb and flow of the tide and/or are presently used, or have been used in the past, or may be susceptible for use to transport interstate or foreign commerce. A determination of navigability, once made, applies laterally over the entire surface of the waterbody, and is not extinguished by later actions or events that impede or destroy navigable capacity." The Brazos River is considered navigable from the Gulf of Mexico to the town of Navasota in Grimes County, Texas. The study area occurs in this navigable reach of the Brazos River.

3.9.3 Endangered Species Act, Sections 7 and 9

When an action or authorization of one federal agency may result in a take ("take" is a specific legal term as defined in 50 CFR 3 and 17), the federal agency (in this case the FHWA) will consult with the USFWS under Section 7 procedures of the Endangered Species Act (ESA). A previously federally threatened species (Bald Eagle) (prior to its August 2007 delisting) occurs within the project vicinity. 50 CFR 402.12 requires the preparation of a Biological Assessment (BA) to establish a baseline of environmental conditions and forecast potential impacts resulting from the project. Under formal Section 7 consultation guidelines, the USFWS may decide to issue a Biological Opinion (BO) and Section 9 Permit for incidental take.

Although the Bald Eagle is no longer protected under the ESA, it is still protected under the Bald and Golden Eagle Protection Act (BGEPA). Per discussions with the USFWS in December 2009, the terms and conditions of existing BOs issued under Section 9 of the ESA would be "grandfathered" in under the BGEPA, therefore, eliminating the need for a

second permit unless project impacts or species information were updated. Therefore, the terms and conditions issued in the BO for Segment C, dated March 7, 2007, remain valid and in effect.

While it is the opinion of the project team and resource agencies that the project would not constitute a take for the Bald Eagles, the Section 9 permit is a precautionary measure to ensure that an illegal take (i.e., take without a permit) does not occur. The project modifications discussed in 1 below compensate for the risk of the potential take.

Two additional points merit discussion in relation to this permit obligation:

1. The ESA does not allow compensation for impacts. The ESA does provide opportunities for the project to be modified to, in effect, mitigate for potential impacts to species or their habitats. In the case of the proposed Grand Parkway Segment C, one option for project modification is for 500 acres (representing one Bald Eagle nest territory) of Austin's Woods to be protected by conservation easement, acquisition or some combination thereof. Other options include land swaps between interested landowners, working within the context of larger conservation initiatives within the area, or monetary contributions in lieu of outright acquisition or easement payment. All options are being considered at this time. In addition, no construction activities may occur within 1 mile of the nest during the eagle nest season (approximately October to May). Vegetation clearing would be minimized and screening vegetation would be conserved or replanted within this 1-mile zone.
2. Detailed information regarding the location of the eagle nest is not available to the public under the TPWD and USFWS policy and private property rights of landowners.

Sections 3.17 and 4.16 provide additional information on threatened and endangered species.

3.10 WETLANDS AND VEGETATIVE COMMUNITIES

3.10.1 Wetlands

The wetland communities present in the study area are typical of palustrine emergent (PEM) and palustrine forested (PFO) areas within southeast Texas as described by Cowardin et al. (1979). Nonforested wetlands may include wet meadows, sloughs, depressions, and pond fringes. Forested wetlands typically occur in depressional areas and along the study area's streams. Descriptions of the nonforested and forested wetland communities in the study area are presented below.

Nonforested Wetlands

According to McMahan et al. (1984), commonly associated plants found in freshwater, nonforested wetlands include water hyacinth (*Eichhornia crassipes*), cattail (*Typha* sp.), water-pennywort (*Hydrocotyle* sp.), pickerelweed (*Pontederia cordata*), arrowhead, white waterlily (*Nymphaea odorata*), cabomba (*Cabomba caroliniana*), coontail (*Ceratophyllum* sp.), and duckweed (*Lemna* sp.). These vegetation communities can be found in hydric lowlands landward of brackish marsh,

coastal prairies, and marshes. This vegetation type corresponds with McMahan et al. (1984) vegetation type 43 (Marsh/Barrier Island).

Nonforested wetlands or PEM (Cowardin et al., 1979) are scattered throughout the study area. A detailed wetland delineation report has been prepared for the Preferred Alternative. Although the nonforested wetlands in the study area are not identical, the following list represents the majority of the vegetation observed in this habitat type during field investigations in the area. Typical vegetation includes eastern gamagrass (*Tripsacum dactyloides*), Arkansas dogshade (*Limnosciadium pinnatum*), bristleleaf eryngo (*Eryngium yuccifolium*), big-headed rush (*Juncus megacephalus*), canna (*Canna glauca*), spatulate leaved frog-fruit (*Phyla nodiflora*), Timothy canarygrass (*Phalaris angusta*), green flatsedge (*Cyperus virens*), bermudagrass (*Cynodon dactylon*), sedge (*Carex* sp.), Drummond's rattlebush (*Sesbania drummondii*), curly dock (*Rumex crispus*), sand spikerush (*Eleocharis montevidensis*), smooth water primrose (*Ludwigia peploides*), jointed flatsedge (*Cyperus articulatus*), hairy hydrolea (*Hydrolea ovata*), flatsedge (*Cyperus* sp.), soft rush (*Juncus effusus*), arrowhead (*Sagittaria* sp.), spiderlily (*Hymenocallis caroliniana*), grassleaf rush (*Juncus marginatus*), Brazilian vervain (*Verbena brasiliensis*), swamp smartweed (*Polygonum hydropiperoides*), Chinese tallow-tree saplings (*Sapium sebiferum*), morning glory (*Ipomoea leptophylla*), bushy bluestem (*Andropogon glomeratus*), St. John's wort (*Hypericum* sp.), thin paspalum (*Paspalum setaceum*), and camphor pluchea (*Pluchea camphorata*).

The majority of the nonforested wetlands observed are considered early successional communities experiencing secondary succession. Many of the nonforested wetlands may have been forested wetlands prior to conversion of the forests to pastureland or agricultural lands. Although these areas may have been forested wetlands in the past, the length of time these wetlands have been converted indicates that the community observed represents the new normal circumstances or community type expected. Due to the ongoing agricultural practices and increasing urban development within the project area, the probability for these areas to revert to forested wetland communities is remote.

In addition to the areas considered to be converted nonforested wetlands, several of the wetlands observed are likely remnant prairie-pothole wetlands that are known to have occurred historically in portions of the study area. Due to the conversion of the land to agricultural uses, these wetlands are also considered early successional wetlands. Continual agricultural practices and other urban development within the majority of the project area make the potential for these wetlands to reach a climax community stage remote.

Forested Wetlands

Forested wetlands, or PFO (Cowardin et al., 1979) are concentrated in the northern and southern regions of the study area. In the northern portion of the study area, forested wetlands are associated with the Rabbs Bayou-Big Creek drainages and the Brazos River floodplain in Thompsons Oil Field. Forested wetlands in the southern portion of the study area are associated with the Big Creek-Brazos River floodplain and Pilant Lake wetland complex, both of which are primarily located in Brazos Bend State Park.

According to McMahan et al. (1984), the plant species associated with forested wetlands include beech (*Fagus americana*), swamp chestnut oak (*Quercus michauxii*), elms (*Ulmus* spp.), sweetgum (*Liquidambar styraciflua*), American sycamore (*Platanus occidentalis*), bald cypress (*Taxodium distichum*), hawthorn (*Crataegus* sp.), dwarf palmetto (*Sabal minor*), poison ivy (*Toxicodendron radicans*), trumpet creeper (*Campsis radicans*), Alabama supplejack (*Berchemia scandens*), and greenbriar (*Smilax* spp.). These wetland areas correspond with McMahan et al. (1984) vegetation type 31 and can be found in forested depressional areas throughout Texas.

Forested wetland communities are generally located south and west of Smithers Lake and north and east of the Brazos River. Several small, forested wetlands can also be observed south of the Brazos River, near Oyster Creek. Vegetation within these areas typically includes water oak (*Quercus nigra*), American sycamore, black willow (*Salix nigra*), planertree (*Planera aquatica*), cottonwood (*Populus deltoides*), sugar hackberry (*Celtis laevigata*), green ash (*Fraxinus pennsylvanica*), dwarf palmetto, seedbox (*Ludwigia* spp.), maidencane (*Panicum hemitomon*), and peppervine (*Ampelopsis arborea*).

The majority of the forested wetlands are considered mid-late successional forested wetland communities. The overstory trees observed were typically between 40 and 60 feet tall, with average diameter at breast height (dbh) ranging from 8 to 12 inches. Typical canopy coverage ranges between 60 and 80 percent.

In addition to the mid-late successional forested wetland communities, several of the forested wetlands appear to be early successional forested wetlands or herbaceous wetlands being converted to forested wetlands. These wetlands are dominated by Chinese tallow, green ash, and black willow trees that range in height from 30 to 50 feet. The average diameter at breast height ranges from 4 to 8 inches and the canopy coverage is typically approximately 50 to 60 percent.

Wetlands provide a variety of ecological functions to the natural ecosystem and to humans. Some of the functions that wetland habitats may provide include wildlife and aquatic habitat, removal of sediment and toxicants, removal or transformation of nutrients, flood and storm damage protection, erosion control, water storage, groundwater recharge and discharge, and natural area buffers. In general, the wetland sites within the project area provide some flood storage, sediment trapping, groundwater recharge, and wildlife habitat.

An important function of wetlands along the proposed Grand Parkway within the Brazos River floodplain and areas adjacent to the floodplain is flood abatement. Typically, wetlands are located in relatively lower topographic positions than nonwetland areas and provide storage capacity for floodwater. In addition to storing the floodwater, the reduction in water volume moving across the land decreases runoff potential and erosion.

Sediment retention is another important wetland function provided by study area wetlands. The sediments that are carried across the land into the wetlands eventually fall out into the wetland, reducing the sediment and nutrient load into the local streams and waterways. As the sediments drop out of the flowing water, various plants act as filters either by absorbing the nutrients or chemicals from the sediments, or by trapping the nutrients/sediments in the soil through the root system of the wetland vegetation. The net result is a reduction of sediments in the waterways and improved water quality.

In addition to their functions related to surface water, wetlands may act as a catch basin for groundwater recharge. As water fills the wetlands, it percolates through the soil to the water table, becoming part of the groundwater. During recharge, as the water percolates through the soil, sediments and nutrients are filtered out by the soils and root zone of the vegetation, cleansing the water before it reaches the water table. This function is probably more pronounced for wetlands within the floodplain of the study area's streams and river. It may be even more pronounced in floodways.

In addition to the surface and groundwater functions, wetlands provide habitat for many wildlife species. For wildlife species that utilize the wetlands, the wetlands provide secure areas with an abundance of food and shelter during different life stages and environmental and climatic conditions. Different guilds or groups of wildlife species may use one or more types of wetlands in the study area.

Human recreational and commercial uses are important functions/values of wetlands. Wetland areas provide multiple recreational uses, such as hiking, wildlife viewing, hunting, and fishing. Of particular interest in the study area is Brazos Bend State Park. The park provides excellent opportunities to view wildlife in typical floodplain forests and wetlands (forested and nonforested) of southeastern Texas. Although hunting is not allowed on park property for typical wetland game animals (e.g., waterfowl), the TPWD does manage a public deer hunt on park grounds during the winter. Fishing opportunities are also provided at the park where piers and bank access have been established on many of the oxbows and naturally occurring lakes.

3.10.2 Vegetative Communities

The study area for the proposed Grand Parkway Segment C is situated in the Texas ecological region known as the Gulf Coast Prairies and Marshes (Gould, 1975). This ecological region is characterized by nearly level topography with precipitation averaging 48 inches per year. The regional elevation extends from sea level along the coast up to 250 feet msl in the uplands of Fort Bend and Brazoria counties with little topographic relief within the study area (Hatch et al., 1990).

The native vegetation of this region originally consisted of tall grass prairies intermixed with post oak savannahs and forested riparian corridors (Hatch et al., 1990; SCS, 1960). Where there has been disturbance or alterations to the landscape, such as farming and ranching and urbanization, various shrubs, exotic trees, and undesirable herbaceous species have invaded. Most of this region is very productive farmland for growing row crops and rice, and because of the urbanization and agricultural activities, very little native prairie remains. The remnant prairie that does exist is dominated by climax grasses such as little bluestem (*Schizachyrium scoparium*), big bluestem (*Andropogon gerardii*), indiangrass (*Sorghastrum nutans*), and gulf muhly (*Muhlenbergia capillaris*). Most of these grasses have been replaced by invaders such as johnsongrass (*Sorghum halepense*), great ragweed (*Ambrosia trifida*), Brazilian vervain, and woody species such as eastern baccharis (*Baccharis halimifolia*) and Chinese tallow-tree.

The northern portion of Fort Bend County and western portion of Brazoria County that would be affected by the proposed Grand Parkway Segment C form an area of increasing urban development. The vegetative communities that are present

include wetland and nonwetland forestlands, pastureland/grassland/cropland, and nonforested wetlands (see site photographs in Appendix H). Forested and nonforested wetlands are described in Section 3.10.1, Wetlands. The following vegetative community descriptions are based on McMahan et al. (1984) and were adjusted to reflect site-specific conditions based on field observations.

Forestlands

Forestlands in the study area may include upland, riparian, and floodplain forests. Species overlap is common and an effort has not been made to differentiate between these forest communities. Forestlands that meet the technical criteria for wetlands (Environmental Laboratory, 1987) are described in Section 3.10.1.

Based on field observations, the majority of the nonwetland forests in the study area are considered late successional or climax forested communities, relative to adjacent or nearby forests. Typical overstory trees are approximately 50 to 70 feet tall with average dbh ranging between 10 and 15 inches. In areas where the forested vegetation has not been cleared, canopy coverage ranges between 80 and 100 percent.

Typical overstory vegetation species found along fencerows and in upper elevations within the study area include cedar elm (*Ulmus crassifolia*), winged elm (*U. alata*), live oak (*Quercus virginiana*), sugarberry (*Celtis laerigath*), and pecan (*Carya illinoiensis*). Lower elevations typically support water oak, black gum (*Nyssa sylvatica*), green ash, and Chinese tallow-tree. These trees are found within floodplains and along streambanks. Understory and shrub species include yaupon (*Ilex vomitoria*), dwarf palmetto, Chinese privet (*Ligustrum sinense*), flowering dogwood (*Cornus florida*), and Chinese tallow. Common vine species include common and laurel greenbriar (*Smilax rotundifolia* and *S. laurifolia*), southern dewberry (*Rubus trivialis*), trumpet creeper, peppervine, Japanese honeysuckle (*Lonicera japonica*), and Alabama supplejack (*Berchemia scandens*). The herbaceous layer includes narrowleaf woodoats (*Chasmanthium sessiliflorum*), Cherokee sedge (*Carex cherokeensis*), maidencane, and curly dock. Many species listed above are typical of forested wetlands (USFWS, 1988) bottomland hardwood forests (McMahan et al., 1984) in the area.

Pastureland/Grassland/Cropland

The pastureland/grassland/cropland community type usually results from the clearing of woody vegetation with the intent of growing a mixture of native and/or introduced grasses and forbs. This clearing practice is common throughout many parts of Texas, and may result in a community that resembles the early stages of a young forest (McMahan et al., 1984). This community type corresponds with McMahan et al. (1984) vegetation type 45. Cropland is defined by McMahan et al. (1984) as any "cultivated cover crop or row crop providing food and/or fiber for either man or domestic animals." McMahan et al. designates this vegetation type 44.

Typical vegetation associated with this community includes eastern gamagrass, snow-on-the-prairie (*Euphorbia bicolor*), annual sumpweed (*Iva annua*), bermudagrass, bahiagrass (*Paspalum notatum*), broomsedge bluestem (*Andropogon virginicus*), little bluestem, indiangrass, dallisgrass (*Paspalum dilatatum*), vasey grass (*Paspalum urvillei*), knotroot bristle

grass (*Setaria geniculata*), southern carpet grass (*Axonopus affinis*), johnsongrass, rescuegrass (*Bromus unioloides*), western ragweed (*Ambrosia psilostachya*), curly dock, Brazilian vervain, smutgrass (*Sporobolus indicus*), bull thistle (*Cirsium horridulum*), honey mesquite (*Prosopis glandulosa*), wild onion (*Allium canadense*), false garlic (*Allium bivalve*), huisache (*Acacia smallii*), sedge, big bluestem, giant ragweed (*Ambrosia artemssiifolia*), giant goldenrod (*Solidago gigantea*), grassleaf rush, perennial ryegrass (*Lolium perenne*), southern dewberry, Macartney rose (*Rosa bracteata*), narrowleaf sumpweed (*Ira annua*), common greenbriar (*Smilax rotundifolia*), gerardia (*Agalinus* sp.), dwarf palmetto, flatsedge (*Cyperus* spp.), Chinese tallow-tree, yaupon, pecan, winged elm, cedar elm, green wild indigo (*Baptisia sphaerocarpa*), green flatsedge, and eastern baccharis.

The pastureland and grassland communities within the area are heavily disturbed, or in some cases, under rotational grazing. Due to intense grazing and the lack of a natural fire regime, these communities are dominated by less desirable grasses and forbs. The grasses within the study area include perennial ryegrass, bermudagrass, southern carpet grass, smutgrass, dallisgrass, vasey grass, bahiagrass, and johnsongrass. Some native species such as indiangrass, little bluestem, and brownseed paspalum (*Paspalum plicatulum*) still exist. Forbs present in the study area include curly dock, giant ragweed, Canada goldenrod, Brazilian vervain, narrowleaf sumpweed, and western ragweed. Commonly occurring shrubs on disturbed pastureland include honey mesquite and Macartney rose.

During the field evaluations, the pastureland/grassland communities were described as early successional communities as a result of past indicators of rotation farming practices. In the majority of the pasturelands/grasslands observed, old rice levees or indicators of ground leveling were documented.

Cropland in the study area is normally used to grow corn, rice, grain sorghum, and soybeans, but cotton and alfalfa are also present. In the abandoned fields, various invading species such as those mentioned above become common. Refer to Section 3.2.4 for a complete description of prime and important farmland soils within the study area.

3.10.3 Natural Areas

For purposes of this document, natural areas are ecologically sensitive areas, including portions of certain important habitats such as bottomland hardwood forest, wetlands, and native tall grass prairie. Forested wetlands are considered one of the more sensitive natural areas in this part of the state. The Brazos River floodplain is centered on a riparian corridor that commonly contains both wetland and nonwetland forests. These forested complexes in Brazoria and Fort Bend counties are referred to by the USFWS as the Austin's Woods (Exhibit 25). These woods succeeded the region's last major timber harvests in the 1930s, thus they are approximately 70-year-old forest stands. This physiographic region originally consisted of coastal bottomland hardwood forests within the 500-year floodplains approximately located south of US 59, east of the Colorado River, and west of SH 6 to the coast. A large forested corridor in the study area connects Thompsons Oil Field and the riparian zones of Big Creek, Waters Lake Bayou, and Rabbs Bayou. The corridor continues through the Pilant Lake wetland complex (located in the park) and out of the study area. Forests in this corridor are considered Austin's Woods.

Three dedicated natural areas were identified within the study area, the Lake Worthington Conservation Area, Brazos Bend State Park, and George Ranch Historical Park (Exhibits 11 and 15). Brazos Bend State Park, Lake Worthington Conservation Area, and the George Ranch Historical Park were described previously in Section 3.3.2.3, Parks and Recreation. George Ranch is also described further in Section 3.18.

3.11 FLOODPLAINS

3.11.1 Hydrology and Drainage

The study area is located within the Brazos River Basin in Fort Bend and Brazoria counties. This basin occurs in the central to southeastern portions of the state. It is bordered by the San Jacinto River Basin on the east and the San Bernard and Colorado River Basins on the west. The Brazos River Basin has a drainage area of over 45,000 square miles (USGS, 1999). The study area receives an average of 48 inches of precipitation annually (Hershfield, 1961). With the project being located in the coastal plain, the grades of the streams are small; therefore, velocities within the channels are slow. The overland slopes in the study area are approximately 4 feet/mile (0.08 percent). The study area consists primarily of undeveloped acreage such as farmlands and wooded areas.

The study area contains numerous major streams, minor streams, irrigation canals, stock ponds, and rivers. Major channels in the study area are Rabbs Bayou, Dry Creek, Big Creek, Brazos River, and Oyster Creek. One unique drainage feature is the Big Creek Diversion Channel recently constructed by the Fort Bend County Drainage District.

3.11.2 Floodways and Floodplains

3.11.2.1 Principle Characteristic of the Project Area

The Segment C study area includes mostly suburban and rural areas southwest of Houston. The topography of the region varies from nearly flat terrain immediately along the Gulf Coast to a gently undulating plain that extends inland approximately 50 to 100 miles (Stutzenbaker, 1999). Floodplains associated with the watercourses in most of the region are typically characterized as wide, flat, and wooded. Each of the major streams within the Segment C study area has floodplains, as identified by FEMA (Exhibit 26).

3.11.2.2 Community Status in the National Flood Insurance Program

The National Flood Insurance Program (NFIP), established by FEMA, has enabled counties and local government agencies the opportunity to map and define the base (100-year) floodplains and special flood hazard areas. The NFIP is administered and enforced through the counties and/or local communities. Under the authority of the NFIP, some communities establish permit requirements for all development within the base floodplain zone. As a result, a community's participation status in the NFIP dictates what type of map is available for estimating potential floodplain encroachments. A community's participation and status in the NFIP is based on one of two programs. The two programs are the Regular Program and the Emergency Program.

Communities participating in NFIP's Regular Program generally have quantitative flood hydraulic studies performed on each floodway. In these communities, the NFIP map is a Flood Insurance Rate Map and in the majority of the cases, a regulatory floodway is in effect. Communities participating in NFIP's Emergency Program generally possess qualitative flood hydraulic data for the floodway. In the Emergency Program, the community's NFIP map is a Flood Hazard Boundary Map showing only approximate base floodplain boundaries.

FEMA, Q3 (electronic) flood data was used for Fort Bend and Brazoria counties (FEMA 2007a, 2007b) to determine 100-year floodplain impact calculations as described in Section 4-10 (Exhibit 26).

3.11.2.3 Segment C Study Area Floodways and Floodplains

The Segment C study area is located within the Brazos River Basin between the San Jacinto River Basin on the east and the San Bernard and Colorado River Basins on the west. The project crosses several FEMA 100-year floodplains. FEMA, Q3 (electronic) flood data Bend and Brazoria counties (FEMA 2007a, 2007b) were referenced to determine the location of 100-year floodplains. The designated flood hazard boundaries in the study area consist of land adjacent to the defined drainage channels for Rabbs Bayou, Dry Creek, Big Creek, Brazos River, and Oyster Creek. The base flood elevation has been determined for most areas located within the 100-year flood zone. In backwater and tributary areas, due to a lack of precise hydraulic information, these base flood elevations have been estimated. The Brazos River floodplain extends from Big Creek on the west to Oyster Creek on the east. The 100-year floodplain is approximately 42.1 percent of the study area, and the 500-year floodplain is approximately 48.8 percent of the study area. Exhibit 26 shows the limits of the floodplains in the study area.

For the Brazos River and upper reaches of Dry Creek, a floodway has been delineated using FEMA, Q3 (electronic) flood data (FEMA, 2007a, 2007b). The floodway is defined as the area within the floodplain where the water is likely to be deep and have high velocities. The floodway is indicated by the area within the floodplain in which if the base flood is encroached equally on both banks, the base flood elevation is increased 1 foot.

The number of insurance claims and total dollars paid since the beginning of the NFIP are shown in Tables 3-19 and 3-20. Although specific locations were not available, only the unincorporated areas listed in the tables are potentially in the study area of the proposed Grand Parkway Segment C.

The floodplain administrators for Brazoria and Fort Bend counties and flood control district officials for areas affected by the proposed Grand Parkway Segment C, including Drainage District #5 (Iowa Colony) in Brazoria County and Fort Bend County Drainage District, were also consulted regarding this project.

TABLE 3-19
TOTAL HISTORICAL NUMBER OF INSURANCE CLAIMS AND TOTAL DOLLARS PAID FOR FLOOD DAMAGES SINCE 1978 IN FORT BEND COUNTY

City/Town	Total Losses (claims)	Total Dollars Paid (historical)
Big Oaks Municipal Utility District (MUD)	1	0
Chelford City MUD	6	23,341
Cities MUD	9	15,725
First Colony	10	5,661
Fort Bend County*	238	3,147,346
Fort Bend County*	20	89,983
Fort Bend County*	10	3,737
Fort Bend County*	14	160,352
Fort Bend County*	3	5,265
Fort Bend County*	2	0
Fort Bend County*	1	0
Fort Bend County*	1	0
Fort Bend County*	3	1,877
Fort Bend County*	2	4,107
Fulshear	14	199,761
Houston	40,972	931,491,355
Katy	45	218,699
Kingsbridge MUD	3	25,941
Meadow Place	16	33,995
Mission Bend MUD	10	47,152
Missouri City	456	1,989,904
Needville	7	140,065
Pecan Grove MUD	12	60,024
Pleak	3	1,703
Richmond	31	322,358
Rosenburg	45	437,848
Simonton	202	4,550,957
Stafford	55	218,096
Sugar Land	179	623,655
Thompsons	0	0
West Keegan Bayou	4	6,619
Willow Fork Drainage Divide	8	35,468
Total	**42,382**	**943,860,994**

Source: NFIP (2009).
*Unincorporated areas

TABLE 3-20
TOTAL HISTORICAL NUMBER OF INSURANCE CLAIMS AND TOTAL DOLLARS PAID FOR FLOOD DAMAGES SINCE 1978 IN BRAZORIA COUNTY

City/Town	Total Losses (claims)	Total Dollars Paid (historical)
Alvin	1,244	12,687,994
Angleton	821	5,837,322
Baileys Prairie	40	289,654
Bonney	0	0
Brazoria County*	6,179	69,912,483
Brazoria City	220	2,540,165
Brookside	190	4,137,295
Clute	308	2,525,578
Danbury	65	482,153
Freeport	924	7,457,266
Hillcrest	53	776,020
Holiday Lakes	8	17,802
Iowa Colony	28	434,723
Jones Creek	102	858,100
Lake Jackson	440	2,008,379
Liverpool	40	409,737
Manvel	259	3,320,355
Oyster Creek	116	873,675
Pearland	2,566	45,344,145
Quintana	15	140,564
Richwood	100	517,679
Surfside Beach	1,289	15,605,424
Sweeny	106	1,923,378
West Columbia	94	1,145,944
Total	**15,207**	**179,245,835**

Source: NFIP Loss Statistics (2009).
*Unincorporated areas

3.11.2.4 Historical Data

A summary of maximum flow measurements is shown in Table 3-21. The historical data for the Brazos River Basin were recorded by two USGS gauging stations located near Richmond and Rosharon, Texas (USGS, 2009). The Richmond gauge has 77 years of recorded data and the Rosharon gauge has around 39 years of recorded data. The gauge station identification numbers are 8114000 and 8116650, respectively. The maximum peak flow rate for the Richmond gauge station was 123,000 cubic feet per second (cfs) on June 6, 1929, and the Rosharon gauge station had its highest flow of 83,900 cfs on October 22, 1994. Water quality properties are also available for the Brazos River at these gauging stations. Physical and field measurements taken at these locations include dissolved oxygen, pH, suspended sediment, turbidity, and instantaneous stream flow. Other water quality properties available are major ions, nutrients, biological measurements, and inorganic trace elements.

TABLE 3-21
MAXIMUM FLOW MEASUREMENTS ALONG THE BRAZOS RIVER

Water Year	Date	Gage Height (feet)	Streamflow (cfs)
Station 08114000 Brazos River at Richmond			
1929	6-Jun-29	N/A	123,000
1941	28-Nov-41	38.4	117,000
1957	5-May-57	37.13	119,000
1961	16-Jan-61	29.66	78,800
1965	25-May-65	34.72	98,800
1968	14-May-68	32.43	89,600
1973	15-Jun-73	31.62	72,500
1977	22-Apr-77	34.05	80,500
1979	8-Jun-79	35.29	88,100
1981	14-Jun-81	29.67	64,700
1982	7-Nov-82	28.8	61,300
1987	17-Jun-87	32.18	67,800
1992	1-Jan-92	49.68	94,000
1995	21-Oct-95	50.3	88,100
1999	22-Oct-99	47.08	80,300
2000	6-May-00	20.76	14,600
2001	17-March-01	35.46	46,700
2002	21-Dec-02	37.52	52,300
2003	7-Nov-03	45.22	74,800
2004	2-Jun-04	43.10	68,300
2005	29-Nov-05	45.84	76,700
2006	10-May-06	18.50	11,900
2007	20-July-07	45.04	72,100
2008	19-May-08	26.54	25,500

TABLE 3-21, CONT'D

Water Year	Date	Gage Height (feet)	Streamflow (cfs)
Station 08116650 Brazos River at Rosharon			
1968	14-May-68	50.74	79,900
1973	15-Jun-73	50.49	79,300
1977	23-Apr-77	48.75	73,000
1979	9-Jun-79	48.56	76,500
1985	26-Oct-85	37.24	45,200
1986	8-Feb-86	37.86	46,700
1987	17-Jun-87	46.6	63,300
1992	3-Jan-92	51.89	82,700
1995	22-Oct-95	51.82	84,400
1999	17-Nov-99	49.42	76,400
2000	10-Jun-00	20.39	13,600
2001	18-March-01	38.66	45,700
2002	21-Dec-02	40.52	43,300
2003	9-Nov-03	47.66	63,700
2004	3-July-04	47.49	64,400
2005	29-Nov-05	49.88	71,100
2006	11-May-06	16.64	11,000
2007	6-Jun-07	48.89	67,800
2008	19-May-08	27.81	25,400

Source: USGS (2009).

3.12 WILDLIFE

3.12.1 Aquatic Habitat

Aquatic habitats in the proposed Grand Parkway Segment C study area support a diverse assemblage of biotic communities characteristic of the Gulf Coast Plain. In addition to the Brazos River and its major tributaries, several small streams, oxbow lakes, wetlands, ponds, and ditches are found within the study area. Waterbodies in this area are typically slow moving or ponded.

The Brazos River in the study area drains approximately 44,000 square miles. The geomorphology of the Brazos River is typical of other Gulf Coast Plains Rivers. Its immediate drainage area has little relief and consists of sandy loam, clay, and sandy soils (BRA, 2001). The river is deep, wide, slow-moving, and typically carries a heavy silt load. Common habitat types include woody debris, overhanging vegetation, undercut banks, cobble, leaf packs, and artificial cover (i.e., broken cement, tires, etc.). Numerous aquatic and semi-aquatic organisms occur in this reach of the river. The TPWD has listed the segment of the Brazos River from Austin/Waller County to the Gulf of Mexico as an "Ecologically Significant River" (TPWD, 2001). Common fish species include catfish (*Ictalurus* spp. and *Pylodictis olivaris*), gar (*Lepisosteus* spp.), crappie (*Pomoxis* spp.), freshwater drum (*Aplodinotus grunniens*), and minnows (*Notropis* and *Cyprinella* spp.) (Hubbs, 1982;

TPWD, 2001). This segment of river is used by anglers who target its catfish and freshwater drum fishery (Simmons, 1986).

Macroinvertebrates in this area include those species typically found in pools or, deep, slow-moving streams. Examples include dragonflies (*Odanata*), crayfish (*Cambaridae*), caddisflies (*Trichoptera*), snails (*Gastropoda*), true bugs (*Hemiptera*), and midge flies (*Chironomidae*). Due to the size and low velocity of the river, various zooplankton (*microcrustacea*) are abundant. The Brazos River also supports mussels including paper pondshell (*Anodonta imbecillis*), giant floater (*A. grandis*), yellow sandshell (*Lampsilis teres*), and washboard (*Megalonaias nervosa*) (Howles et al., 1996).

All other waterbodies in the study area ultimately drain into the Brazos River and support much of the same fauna. These habitats are either ponded (wetlands, ponds, ditches, backwaters, etc.) or are slow-moving streams. Dominant habitat features include emergent aquatic plants, overhanging vegetation, leaf packs, woody debris, and, in streams, undercut banks. Many fish species in the Brazos River use these tributaries, backwaters, and floodplain impoundments as spawning grounds and nursery areas. Other species characteristic of small streams and quiescent backwaters are also found in the project area.

These include sunfish (*Lepomis* spp.), largemouth bass (*Micropterus salmoides*), pirate perch (*Aphredoderus sayanus*), topminnows (*Fundulus* spp.), bowfin (*Amia calva*), and numerous other species. These habitats also support diverse aquatic invertebrate communities including mayflies (*Ephemeroptera*), crayfish, caddisflies, dragonflies, midge flies, snails, water scorpions (*Nepidae*), beetles (*Coleoptera*), aquatic worms (*Oligocheata*), and zooplankton.

Waterbodies within the study area also provide important habitat and services to other semi-aquatic organisms such as the American alligator (*Alligator mississippiensis*); American beaver (*Castor canadensis*); turtles, such as the red-eared slider (*Trachemys scripta elegans*), Midland smooth softshell turtle (*Trionyx muticus*); wading birds; and waterfowl. These and other organisms are dependent upon these areas for food, water, and refuge.

Brazos Bend State Park is included in the study area and contains extensive aquatic habitats including wetlands, oxbow lakes, and ponds. Many of the aquatic and semi-aquatic life that occur in the study area can also be found here. Common sport fish in the park are crappie, largemouth bass, and channel catfish (*Ictalurus punctatus*). The proximity of the park to the Houston metropolitan area makes it a popular recreation area. The park offers opportunities for the public to camp, fish, hike, bird watch and a number of other outdoor activities, many of which are centered around its aquatic habitats.

3.12.2 Terrestrial Wildlife

Brazoria and Fort Bend counties occur within the Texan Biotic Province as described by Blair (1950). The Texan Biotic Province represents a transitional area between the forested province to the east and grassland provinces to the west. The integration of forests and grasslands in the area results in a mixture of vertebrate species typical of the two general habitats. The majority of the native vegetation in the province has been replaced by cultivated crops, improved pasture

grasses, invasive brush, or urban development. Consequently, numerous native wildlife populations have declined. Many habitat specialists, including the least shrew (*Cryptotis parva*), Texas horned lizard (*Phrynosoma cornutum*), and northern bobwhite (*Colinus virgianus*) have undergone significant reductions in numbers and had their distributions severely altered, while other more generalistic species such as the coyote (*Canis latrans*), eastern meadowlark (*Sturnella magna*), and mourning dove (*Zenaida macroura*) apparently have increased in number and habitat occupation.

Approximately 49 species of mammals occur (or have historically occurred) in the Texan Province, of which only 8 are grassland species encroaching from the west, southwest, or north. Two species of land turtles occur in the Texan Province. Nine of the 16 lizard species occurring in the Texan Province are eastern forest species, and the remaining 7 are western grassland affiliates. Of the 39 species of snakes documented in the Texan Province, 27 are eastern forest species and 12 are western. Five salamanders (all eastern forest species) and 18 species of frogs and toads (15 of which are eastern forest species) occur in the Texan Biotic Province (Blair, 1950).

The terrestrial wildlife habitats within the study area correspond to the vegetation types presented in Section 3.10.2, and include grassland/pastureland/cropland, forestland, forested wetlands, and nonforested wetlands. The distribution of habitat types in the study area and the activity patterns of many wildlife species result in some overlapping of faunal communities. Forest-dwelling species may occasionally occur in open areas around forest stands, and species particular to nonforested habitats may occasionally be found in forested areas. Edge areas, or ecotones, between major habitats are often preferred by wildlife species because of the diversity of food and cover usually provided by the overlap of vegetative communities. Literature reviewed to identify species of potential occurrence within the study area habitats include Tennant (1998) and Bartlett and Bartlett (1999) for reptiles and amphibians, Texas Ornithological Society (TOS, 1995) for avian species, and Manning and Jones (1998) for mammals.

3.12.3 Migratory Birds

The Migratory Bird Treaty Act (1918) (MBTA) protects migratory birds, active nests, eggs, and/or young. In the event that migratory birds are encountered on site during project construction, every effort would be made to avoid harm to migratory birds, their eggs, nests, and young. If necessary, old migratory bird nests would be removed from structures after the nesting season. For upcoming construction, preventative measures would be taken to prevent birds from building new nests on the proposed construction area.

3.12.4 Pastureland/Grassland/Cropland

The pastureland/grassland/cropland habitat type is the most abundant habitat found in the study area. Although the general purpose of this habitat is to grow crops or graze livestock, much of this habitat is out of production at any given time as farmers and ranchers rotate their stock to allow the land to recover before returning the land to its intended use. This results in a mixture of native and/or introduced grasses and forbs with early successional woody vegetation in many areas. Due to the agricultural aspect of the study area, some tracts are inundated with water for extended periods that contribute to habitat for mid-continental waterfowl, wading birds, and other water-dependent vertebrate species.

Between 350 and 400 species of birds occur as migrant and winter resident species in the study area and include many species of waterfowl (Smeins, 1994). In autumn, following crop production, migratory birds arrive to the area for wintering grounds and remain until March. Some of the common waterfowl associated with the study area's inundated agricultural fields include the green-winged teal (*Anas crecca*), northern pintail (*Anas acuta*), common gadwall (*Anas strepera*), American widgeon (*Anas americana*), lesser scaup (*Aythya affini*), northern shoveler (*Anas clypeata*), snow goose (*Chen caerulescens*), and greater white-fronted goose (*Anser albifrons*). Year-round residents that may occur include such species as the great blue heron (*Ardea herodias*), great egret (*Ardea alba*), white-faced ibis (*Plegadis chihi*), killdeer (*Charadrius vociferous*), black vulture (*Coragyps atratus*), turkey vulture (*Cathartes aura*), red-tailed hawk (*Buteo jamaicensis*), northern bobwhite, mourning dove, American crow (*Corvus brachyrhynchos*), northern mockingbird (*Mimus polyglottos*), European starling (*Sturnus vulgaris*), northern cardinal (*Cardinalis cardinalis*), red-winged blackbird (*Agelaius phoeniceus*), eastern meadowlark, and savannah sparrow (*Passerculus sandwichensis*). Other avian migrant/winter resident species expected to occur in the study area include the American robin (*Turdus migratorius*), chipping sparrow (*Spizella passerina*), Brewer's blackbird (*Euphagus cyanocephalus*), and the savannah sparrow (*Passerculus sandwichensis*). Avian species, which may nest in the study area during spring and summer, include the common nighthawk (*Chordeiles minor*) and the eastern kingbird (*Tyrannus tyrannus*).

The Gulf Coast toad (*Bufo valliceps valliceps*) and Woodhouse's toad (*Bufo woodhousii*) are the most likely amphibians to occur in the study area's inundated agricultural fields. Other amphibians found in drier pastures and grasslands include the spotted chorus frog (*Pseudacris clarkii*) and southern leopard frog (*Rana utricularia*). One terrestrial turtle species, the ornate box turtle (*Terrapene ornata ornata*), could occur in this habitat type. Common lizard species that may occur throughout the study area include the green anole (*Anolis carolinensis*) and ground skink (*Scincella lateralis*). Snake species that may occur in the study area include the Texas rat snake (*Elaphe obsolete lindheimeri*), Gulf Coast ribbon snake (*Thamnophis proximus orarius*), and the rough earth snake (*Virginia striatula*). Several venomous species of snakes may also occur within the study area, including the southern copperhead (*Agkistrodon contortrix contortrix*) and western cottonmouth (*Agkistrodon piscivorus leucostoma*).

Mammal species that may occur throughout the pastureland/grassland/cropland habitat include the Virginia opossum (*Didelphis virginiana*), common raccoon (*Procyon lotor*), house mouse (*Mus musculus*), eastern cottontail (*Sylvilagus floridanus*), swamp rabbit (*S. aquaticus*), striped skunk (*Mephitis mephitis*), marsh rice rat (*Oryzomys palustris*), hispid cotton rat (*Sigmodon hispidus*), northern pygmy mouse (*Baiomys taylori*), coyote, common gray fox (*Urocyon cinereoargenteus*), feral pig (*Sus scrofa*), and white-tailed deer (*Odocoileus virginianus*).

3.12.5 Forestlands

The nonwetland forested areas (Austin's Woods) include mixed hardwood woodlands found in uplands and floodplains (including riparian edges) within the study area. This habitat type is widespread throughout the study area and provides cover and edge habitat for a variety of wildlife. Wildlife movement patterns are variable due to the amount of food, cover, and water provided in a particular area.

Amphibians likely to occur within the study areas wooded habitats include the northern cricket frog (*Acris crepitans crepitans*), upland chorus frog (*Pseudacris triseriata feriarum*), bronze frog (*Rana clamitans clamitans*), northern spring peeper (*Pseudacris crucifer*), and the smallmouth salamander (*Ambystoma texanum*). One terrestrial species of turtle that may occur in upland (nonwetland) forest habitat is the three-toed box turtle (*Terrapene carolina triunguis*). Common lizard species that may occur include the five-lined skink (*Eumeces fasciatus*) and the northern fence lizard (*Sceloporus undulatus hyacinthinus*). Snake species that may occur in this habitat type include the eastern hognose snake (*Heterodon platirhinos*), rough earth snake (*Virginia striatula*), and rough green snake (*Opheodrys aestivus*). Venomous species of snakes that may occur within the study area include the Texas coral snake (*Micrurus fulvius tener*) and western pigmy rattlesnake (*Sistrurus miliarius streckeri*).

Avian residents likely to occur in these forested areas include the white-eyed vireo (*Vireo griseus*), red-shouldered hawk (*Buteo lineatus*), Carolina chickadee (*Poecile carolinensis*), tufted titmouse (*Baeolophus bicolor*), red-bellied woodpecker (*Melanerpes carolinus*), blue jay (*Cyanocitta cristata*), Carolina wren (*Thryothorus ludovicianus*), barred owl (*Strix varia*), and eastern screech owl (*Otus asio*) in addition to those found in pastureland/grassland/cropland habitat. Seasonal nesting species include the yellow-billed cuckoo (*Coccyzus americanus*), red-eyed vireo (*Vireo olivaceus*), Swainson's warbler (*Limnothlypis swainsonii*), summer tanager (*Piranga rubra*), and great crested flycatcher (*Myiarchus crinitus*). The forested areas in the study area also provide important habitat for neotropical species during fall and winter migrations, such as the yellow-bellied sapsucker (*Sphyrapicus varius*), northern flicker (*Colaptes auratus*), eastern phoebe (*Sayornis phoebe*), ruby-crowned kinglet (*Regulus calendula*), hermit thrush (*Catharus guttatus*), cedar waxwing (*Bombycilla cedrorum*), orange crowned warbler (*Vermivora celata*), yellow-rumped warbler (*Dendroica coronata*), and white-throated sparrow (*Zonotrichia albicollis*).

Mammal species that may occur throughout the forested areas include species found in the pastureland/ grassland/cropland habitat, as well as the eastern fox squirrel (*Sciurus niger*), eastern gray squirrel (*Sciurus carolinensis*), and eastern red bat (*Lasiurus borealis*).

3.12.6 Nonforested Wetlands

Nonforested wetlands tend to provide habitat for more water-dependent species, such as wading birds, waterfowl, and other aquatic species similar to those commonly occurring in the inundated agricultural fields described above. Additional aquatic species favoring this habitat type include the American alligator (*Alligator mississippiensis*), diamondback water snake (*Nerodia rhombifer*), broad-banded water snake (*Nerodia fasciata confluens*), green tree frog (*Hyla cinerea*), bull frog (*Rana catesbeiana*), nutria (*Myocastor coypus*), and American beaver.

3.12.7 Forested Wetlands

Many of the wildlife species likely to occur in this habitat type are the same as those found in nonwetland forest habitats since these habitats are so closely associated within the study area. Forested wetlands also support American alligators; water snakes including the broad-banded water snake (*Nerodia fasciata confluens*) and western mud snake (*Farancia*

abacura reinwardtii); common turtle species including the Mississippi mud turtle (*Kinosternon subrubrum hippocrepis*) and red-eared slider (*Trachemys scripta elegans*); and amphibians including Blanchard's cricket frog (*Acris crepitans blanchardi*), Cope's gray treefrog (*Hyla chrysoscelis*), and gray tree frog (*Hyla versicolor*).

In addition to wildlife, several species of domesticated animals are found within the region. Those commonly observed are cats (*Felix domesticus*), dogs (*Canis familiaris*), cattle (*Bos taurus* and *B. indicus*), horses (*Equus caballus*), and feral pigs (*Sus scrofa*).

3.13 WILD AND SCENIC RIVERS

The Wild and Scenic Rivers Act describes those river areas eligible to be included in a system afforded protection under the Act as free flowing and possessing outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values.

The study area is not situated in the vicinity of any river on the National Inventory of river segments included in the National Wild and Scenic River System (NPS, 1999b).

The study area does include a listed unique stream segment. The portion of Big Creek within the Brazos Bend State Park was nominated as a stream of unique ecological value by the Region H Water Planning Board. The stream segment was recommended because the bottom hardwoods and associated wetlands provide valuable water quality; part of the Great Texas Coastal Birding Trail; and, designated as an Ecoregion Reference Stream by the TPWD River Studies Program for high dissolved oxygen and diversity of benthic macro invertebrates.

3.14 COASTAL BARRIERS

Coastal barriers are undeveloped areas on barrier islands and peninsulas or otherwise protected areas, as mapped by the United States Department of the Interior, General Land Office (GLO, 1994) Texas Coastal Management Program (TCMP). Coastal barriers can include coastal natural resources that provide sediment utilized in coastal processes and provide food and/or habitat for numerous faunal species. The landward boundaries of coastal barriers are distinct at the shoreline of bays and estuaries.

Part of the TCMP is to ensure the protection and/or restoration of these coastal barriers. City and county governments located in counties with barrier islands implement the TCMP policies related to preservation of beach access and dune protection. This is accomplished through development of Beach Access and Dune Protection Plans consistent with the TCMP policies per the Open Beaches Act, Dune Protection Act, and floodplain requirements. Participating agencies that review these protection plans include the Texas GLO, School Land Board, and the Office of the Attorney General. In addition, the TCEQ and TxDOT implement policies related to managing undeveloped areas of barrier islands through approval of special districts and transportation projects on barrier islands.

Fort Bend County does not have any coastal barrier resources. Brazoria County does have coastal barrier resources in the southern portion of the county. However, the study area is wholly outside any coastal barrier systems.

3.15 COASTAL ZONE MANAGEMENT

The Coastal Zone Management Act of 1972, as amended, provides for preservation, protection, development, and where feasible, restoration and enhancement of the nation's coastal zone resources. The State of Texas now has an approved TCMP (approved by the NOAA on December 23, 1996, as published in the FR [Volume 62, Number 7] on January 10, 1997).

The GLO is the state's designated lead agency that coordinates the development and implementation of the TCMP. Prior to the TCMP, various state and federal agencies, cities, and counties managed the state's coastal resources as dictated by regional issues or other state and federal regulatory mechanisms (e.g., the CWA). These entities will continue to implement the TCMP through ongoing programs where appropriate. However, existing programs are required to ensure consistency with the TCMP.

The boundary of the Texas Coastal Management Zone (CMZ) was delineated in accordance with the requirements of the Federal Coastal Zone Management Act, federal program development and approval regulations, and Texas Coastal Coordination Act. Requirements dictate that a state's coastal zone boundaries include four elements: inland boundary, seaward boundary, interstate boundaries, and federal lands excluded from the boundary.

No portion of Fort Bend County is included in the CMZ. Although the southern portion of Brazoria County is included in the CMZ, the study area for the proposed Grand Parkway Segment C lies approximately 13.5 miles north of the Texas CMZ. Coastal wetlands within the Chocolate Bayou riparian corridor in Brazoria County are approximately 6.5 miles from the study area (GLO, 1996).

3.16 ESSENTIAL FISH HABITAT

The Magnuson-Stevens Fishery Conservation and Management Act, as amended on October 11, 1996, directs that all federal agencies whose actions will impact essential fish habitat (EFH) must consult with the National Marine Fisheries Service (NMFS) regarding potential adverse effects. As a result, any project receiving federal funding must address potential impacts to EFH. The proposed project is outside the limits of tidally influenced, coastal waters and would not impact EFH; therefore, coordination with the NMFS is not required.

3.17 THREATENED AND ENDANGERED SPECIES

Table 3-22 includes those plant and wildlife species that are considered by the USFWS and TPWD to be federally and state-listed endangered, threatened or a candidate species and have a potential of occurrence in the project area. Sources reviewed to develop the list include the USFWS online database (2011), Poole et al. (2000), the TPWD's online Annotated

TABLE 3-22
ENDANGERED AND THREATENED PLANTS AND WILDLIFE OF POTENTIAL OCCURRENCE IN BRAZORIA AND FORT BEND COUNTIES

Common Name	Scientific Name	State Status	Federal Status	Habitat Description	County	Habitat Present within Study Area	Effect/Impact
AMPHIBIANS							
Houston Toad	*Bufo houstonensis*	E	E†	Sandy soil, breeds in ephemeral pools	Fort Bend	No	No
BIRDS							
American Peregrine Falcon	*Falco peregrinus anatum*	E	DM†	Potential migrant	Both	Yes	No
Arctic Peregrine Falcon	*Falco peregrinus tundrius*	SOC	DM†	Potential migrant	Both	Yes	No
Attwater's Greater Prairie-Chicken	*Tympanuchus cupido attwateri*	E	E†	Open prairies of mostly thick grass 1 to 3 ft tall; from near sea level to 200 ft along coastal plain on upper 2/3 of Texas coast	Fort Bend	No	No
Bald Eagle (Nesting)	*Haliaeetus leucocephalus*	T	DM	Near water areas, in tall trees	Both	Yes	No
Black Rail	*Laterallus jamaicensis*	SOC		Marshes, pond borders, wet meadows, and grassy swamps	Brazoria	No	No
Brown Pelican (Nesting)	*Pelecanus occidentalis*	E	DM	Island near coastal areas	Brazoria	No	No
Eskimo Curlew	*Numenius borealis*	E	E†	Grasslands, pastures, plowed fields, marshes, mudflats	Brazoria	No	No
Henslow Sparrow (winterin)	*Ammodramus henslowii*	SOC		weedy fields, fields with bunch grass, vines, and brambles, need bare ground	Both	Yes	No
Interior Least Tern	*Sterna antillarum athalassos*	E	E†	Nests along sand and gravel bars within streams and rivers, only listed when 50 miles inland.	Fort Bend	No	No
Piping Plover (Wintering)	*Charadrius melodus*	T	E, T	Beach and bayside mud or salt flats	Brazoria	No	No
Reddish Egret	*Egretta rufescens*	T	*	Brackish marshes and tidal flats	Brazoria	No	No
Snowy Plover	*Charadrius alexandrinus*	SOC		Coastal winter migrant	Brazoria	No	No
Southeastern Snowy Plover	*Charadrius alexandrinus tenuirostris*	SOC		Winter migrant on Texas coast beaches, bayside mud or salt flats	Brazoria	No	No
Sooty Tern	*Sterna fuscata*	T	*	Maritime bird	Brazoria	No	No
Sprague's Pipit	*Anthus spragueii*	--	C†**	Migrant, upland prairie, coastal grasslands	Both	Yes	No
Western Burrowing Owl	*Athene cunicularia hypugaea*	SOC		Open grasslands, prairie, plains, and savannahs	Fort Bend	No	No
Western Snowy Plover	*Charadrius alexandrinus nivosus*	SOC		Coastal winter migrant	Brazoria	No	No
White-faced Ibis	*Plegadis chihi*	T	†*	Freshwater marshes, but some brackish or salt marshes	Both	Yes	No
White-tailed Hawk	*Buteo albicaudatus*	T	*	Coastal Prairies	Both	Yes	No
Whooping Crane	*Grus americana*	E	E, EXPN	Winters in Aransas National Wildlife Refuge	Both	Yes	No
Wood Stork	*Mycteria americana*	T	*, E†	Prairie ponds and flooded pastures	Both	Yes	No
MAMMALS							
Jaguarundi	*Herpailurus yaguarondi*	E	E†	Thick brushland near water	Brazoria	No	No
Louisiana Black Bear	*Ursus americanus*	T	T†	Bottomland hardwoods; large, undisturbed forested areas	Both	No	No
Ocelot	*Leopardus pardalis*	E	E†	Dense chaparral; mesquite-thorn scrub and live oak mottes	Brazoria	No	No

TABLE 3-22, CONT'D

Common Name	Scientific Name	State Status	Federal Status	Habitat Description	County	Habitat Present within Study Area	Effect/Impact
Plains Spotted Skunk	*Spilogale putoria interrupta*	SOC	*	Open fields, prairies, croplands, fence rows, farm yards, brushy areas, and tall grass prairies	Brazoria	Yes	No
Red Wolf	*Canis rufus*	E	E†*	Extirpated, brushy, forested areas, coastal prairies	Both	No	No
West Indian Manatee	*Trichechus manatus*	E	E††	Gulf and bay system	Brazoria	No	No
FISH							
American Eel	*Anguilla rostrata*	SOC		Coastal waterways below reservoirs to gulf	Both	No	No
Sharpnose Shiner	*Notropis oxyrhynchus*	SOC	C, C†	Large turbid river, sand, gravel, and clay-mud bottom	Both	Yes	No
Smalltooth Sawfish	*Pristis pectinata*	E	E†	Sheltered bays, shallow banks, estuaries and river mouths	Brazoria	No	No

Source: USFWS (2011); Poole et al. (2000); TPWD (2011a, 2011b).
*These species occur on the state listing of threatened or endangered species; however, they are not federally listed at this time by the U.S. Fish and Wildlife Service (2011).
†These species are listed by the U.S. Wildlife Service; however, they are not listed to occur within this county by the Clear Lake office of the U.S. Fish and Wildlife Service (2011).
--Not listed for Texas Parks and Wildlife Department for this county.
E = endangered T = threatened H = historical occurrence I = introduced population C = candidate species SOC = species of concern DM = delisted taxon, recovered, being monitored first 5 years SAT = similarity of appearance to a threatened taxon, EXPN=Experimental population, Nonessential.

County List of Rare Species for Fort Bend and Brazoria counties (2011a), and Texas Natural Diversity Database [NDD]) (TPWD, 2011b). It should be noted that inclusion on the list does not imply that a species is known to occur in the study area for the proposed project, but only acknowledges the potential for occurrence. Only those species listed as endangered or threatened by the USFWS are afforded complete federal protection and are therefore discussed individually here.

In December 2011, a literature review of the Texas NDD, a continually updated data source, was conducted to identify known occurrences of threatened/endangered species within the study area for the proposed project. Based on a review of the Texas NDD (TPWD, 2011b), there are three documented occurrences of the Bald Eagle within the study area. No other documented occurrences of federally or state-listed endangered, threatened, or candidate species were present within the study area; however, it should be noted that a lack of documented occurrences does not mean listed species or their habitat are absent from the study area (TPWD, 2011b).

According to the USFWS, currently there are 106 species in the State of Texas federally listed threatened, endangered, or candidates for listing as threatened or endangered (USFWS, 2011). Of these, 13 species are listed by the USFWS (2011) as potentially occurring in Brazoria and Fort Bend counties. Additionally, 29 state-listed threatened or endangered species are included on the Annotated County List of Rare Species (TPWD, 2011a). Below are brief descriptions of the federally and state listed threatened and endangered species.

Amphibians

Houston Toad

The Houston toad (*Bufo houstonensis*), a federally and state-listed endangered species is included within the TPWD Annotated County List for Fort Bend County; however, this species is not listed as potentially occurring within either of the two counties crossed by the USFWS. According to the Texas NDD (TPWD, 2011b), there are no occurrences of the Houston toad recorded within 1 mile of the Representative Alternatives. Loose sandy soil habitats required to provide habitat for the Houston toad are not present within the study area; therefore, the proposed project would have no effect on the Houston toad

Birds

American and Arctic Peregrine Falcon

The American peregrine falcon, state-listed threatened species, is a rare migrant statewide, and nests in the mountains of Trans-Pecos Texas, while the Arctic peregrine falcon is an uncommon migrant statewide and an uncommon winter resident on the Coastal Prairies and coast, where it typically occurs near bays and estuaries (Lockwood and Freeman, 2004). The USFWS recently removed the peregrine falcon from its list of endangered and threatened species, but the American and Arctic subspecies retain their state-listed status. Suitable nesting or wintering habitat is present in the project area; however, there are no documented occurrences of the American or Arctic peregrine falcon within 1 mile of the Representative Alternatives. The proposed project would have no impact on the American peregrine or Arctic peregrine falcon or their preferred habitats within the vicinity of the project.

Attwater's Prairie-chicken

The Attwater's prairie-chicken a federally and state-listed endangered species is included within the TPWD Annotated County List for Fort Bend County; however, this species is not listed as potentially occurring within either of the two counties crossed by the USFWS. Attwater's prairie-chickens live on coastal prairie grasslands with tall grasses, such as little bluestem, indiangrass, and switchgrass. The birds like a variety of tall and short grasses in their habitat. They gather to choose a mate in an area of bare ground or short grass where the males can be easily seen by the females. Hens build their nest in tall grass and usually lay 12 eggs during nesting season. The eggs hatch in April or May. Small green leaves, seeds, and insects form the diet of the Attwater's prairie-chicken. Attwater's prairie-chickens live about 2 to 3 years in the wild (TPWD, 2011b). Based on a review of NDD files (TPWD, 2011b) and field investigations, no preferred habitat for the Attwater's prairie-chicken occurs within the Representative Alternatives. The proposed project would have no effect on the Attwater's prairie-chicken.

Bald Eagle

The Bald Eagle was delisted by the USFWS on August 8, 2007. The health of the Bald Eagle population will be monitored for the next 5 years, and the eagle could be reclassified after the 5-year monitoring period. The Bald Eagle is still listed as threatened by the TPWD. Additionally, the Bald Eagle is protected by the MBTA and the BGEPA. As described in Section 3.17, under the MBTA it is illegal to pursue, hunt, take, capture, kill, possess, sell, barter, purchase, export, or import migratory birds, their parts, nests or eggs, except as permitted by regulation. Additionally, "take" is defined under the MBTA as "pursue, hunt, shoot, wound, kill, trap, capture, possess, or collect" (USFWS, 2007a). The BGEPA prohibits the take, possession, sale, purchase, barter, offer to sell, purchase, or barter, transport, export or import, of any bald or golden eagle, alive or dead, including any part, nest, or egg, unless allowed by permit. "Take" is defined as "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb" a bald or golden eagle. The term "disturb" under the BGEPA was recently defined by a final rule published in the FR on June 5, 2007. "Disturb" means to agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available, (1) injury to an eagle, (2) a decrease in its productivity by substantially interfering with normal breeding, feeding, or sheltering behavior, or (3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior (USFWS, 2007b).

Three Bald Eagle nests are known to exist within the study area vicinity. Two nests are located north of Smithers Lake and appear to be utilized by the same nesting pair. The other nest is located southeast of Lake Worthington. All three nests were observed in the field by study team ecologists during the 2000 DEIS field studies. An adult and an immature Bald Eagle were observed near the southern nest during field surveys conducted in February, March, and April 1999; an adult pair was observed near the newest nest location (February 2005). Observations from field visits between 2000 and 2005 confirmed the nest sites originally reported in the DEIS are still intact. In February 2005, during another field visit, it appeared that a branch supporting the nest had broken, and the nest had fallen to the ground. During the same field visit another nest was observed approximately 1,350 feet southwest of the previously documented nest and was assumed to have been constructed by the same nesting pair. The proposed project would have no effect on the Bald Eagle.

Brown Pelican

The federally and state-listed endangered Brown pelican (*Pelecanus occidentalis*) is primarily a coastal species that rarely ventures very far out to sea or inland. In Texas, it occurs primarily along the lower and middle coasts, but occasional sightings are reported on the upper coast and inland to central, north-central, and eastern Texas, usually on large freshwater lakes (TOS, 1995); however, such occurrences are relatively uncommon. The Brown pelican has been recorded from Brazoria County (Oberholser, 1974); however, coastal habitats and/or large freshwater lakes are not present within the study area. Impacts to the Brown pelican are not expected as a result of the proposed project; therefore, the project would have no effect on the Brown pelican.

Eskimo Curlew

The Eskimo curlew (*Numenius borealis*), a federally and state-listed endangered species is included within the TPWD Annotated County List for Brazoria County; however, this species is not listed as potentially occurring within either of the two counties crossed by the USFWS. The species is considered to be extinct, or nearly so. The last few observations on the Texas coast were in the 1960s (Linam et al., 1994). Furthermore, according to the Texas NDD (TPWD, 2011b), there are no occurrences of the Eskimo curlew recorded within 1 mile of the Representative Alternatives; therefore, impacts to the Eskimo curlew are not expected as a result of the proposed project. The proposed project would have no effect on the Eskimo curlew.

Piping Plover

The federally listed endangered and federally and state-listed threatened Piping plover (*Charadrius melodus*) is a regular post-breeding migrant along the Texas coast, where it overwinters (Oberholser, 1974; TOS, 1995), potentially occurring in Brazoria County. The Piping plover can be found along Texas beaches and tidal flats generally from mid-July through April. Preferred habitat for the Piping plover is larger expanses of coastal, intertidal sand or mud flats. This species has been observed in Brazoria County (Oberholser, 1974); however, preferred habitats for the Piping plover are not present within the study area. Impacts to the Piping plover are not expected as a result of the proposed project; therefore, the proposed project would have no effect on the Piping plover.

Interior Least Tern

The Interior least tern, a federally listed and state-listed endangered species, is included within the TPWD Annotated County List for Fort Bend County; however, this species is not listed as potentially occurring within either of the two counties crossed by the USFWS. In Texas, the state-listed endangered Interior least tern historically nested on sandbars of the Colorado River, Red River, and Rio Grande. At present time, small breeding populations exist at isolated locations within the species' historic range, although the species' winter range includes the entire Texas Gulf Coast. The Interior least tern's preferred nesting habitat is unvegetated, frequently flooded sand flats, salt flats, sand and gravel bars, and sand, shell, and/or gravel beaches (Campbell, 1995; Thompson et al., 1997). The habitats described above are not present within the vicinity of proposed project, and according to the Texas NDD (TPWD, 2011b), there are no occurrences of the Interior least tern within 1 mile of the Representative Alternatives; therefore, the proposed project would have no effect on the Interior Least Tern.

Reddish Egret

The Reddish egret, a state-listed threatened species, typically inhabits salt bays and marshes. Its breeding range is restricted to the Gulf Coast where it commonly nests in yucca-pricklypear thickets (Oberholser, 1974). The Reddish egret may occur within the project area during post-breeding visits. Based on a review of NDD files (TPWD, 2011b) and field

investigations, no preferred habitat for the Reddish egret occurs within the Representative Alternatives. The proposed project would have no impact on the Reddish egret.

Sooty Tern

The state-listed threatened Sooty tern 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 spoil 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). Because there are no coastal waters present within the project area, potential habitats for the Sooty tern would not be present in the project area. Furthermore, according to the Texas NDD (TPWD, 2011b), there are no occurrences of the Sooty tern within 1 mile of the Representative Alternatives; therefore, the proposed project would have no effect on the Sooty tern.

Sprague's Pipit

Sprague's pipit is a federal candidate for listing as threatened or endangered within the counties crossed by the project. Sprague's pipit would be considered a wintering migrant, potentially occurring in native upland prairie grasslands (Jones, 2010). Because native prairie grasslands are not common within the vicinity of the project, occurrences of this species are unlikely; therefore, the proposed project would have no effect on Sprague's pipit.

White-faced Ibis

The White-faced ibis, a state-listed threatened species, forages bays, marshes, lakes, and ponds (Rappole and Blacklock, 1994). The proposed project would have a negligible impact on marshes and is not likely to adversely impact any White-faced ibis that might be present in the vicinity of the project.

White-tailed Hawk

The state-listed threatened White-tailed hawk 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). This species may occur in the general vicinity of the project area. The proposed is not likely to adversely impact any White-tailed hawk that might be present in the vicinity of the project.

Whooping Crane

The proposed project lies within the historic wintering range and within the migration corridor of the Whooping crane, a federally and state-listed endangered species. Each fall, the entire population from the Wood Buffalo National Park in northern Canada migrates primarily to the Aransas National Wildlife Refuge and adjacent areas of the central Texas coast

in Aransas, Calhoun, and Refugio counties to overwinter (USFWS, 1995). During migration, these birds may stop at small stock ponds or other waterbodies occurring in pastureland and feed in cultivated fields such as sorghum or corn. The Whooping crane is a potential migrant through the project area, since it has been recorded from both counties, including Fort Bend County at Brazos Bend State Park (Oberholser, 1974); however, the proposed project would not impact critical habitats for the whooping crane. The proposed project would have no effect on the Whooping crane.

Wood Stork

The Wood stork, a state-listed threatened species, is an uncommon to common post-breeding visitor to the central and upper coastal prairies and a regular visitor of lakes and reservoirs in central and east Texas. The Wood stork forages in shallow standing water, including saltwater, and usually roosts communally in tall snags; however, the Wood stork has not been known to nest in Texas since 1960. The proposed project would have a negligible impact wood stork habitat and not likely to adversely impact the Wood stork.

Mammals

Jaguarundi

The jaguarundi (*Herpailurus yagouaroundi*), a federally and state-listed endangered species is included within the TPWD (2011a) Annotated County List for Brazoria County; however, this species is not listed as potentially occurring within either of the two counties crossed by the USFWS. The jaguarundi is considered to have historically resided in the study area counties; however, the project area is not within its current range of occurrence. Furthermore, according to the Texas NDD (TPWD, 2011b), there are no occurrences of the jaguarondi within 1 mile of the Representative Alternatives; therefore, the proposed project would have no effect on the jaguarondi.

Louisiana Black Bear

The Louisiana black bear (*Ursus americanus*), a federally and state-listed threatened species is included within the TPWD (2011a) Annotated County List for both counties crossed by the project; however, this species is not listed as potentially occurring within either of the two counties crossed by the USFWS. The Louisiana bear is considered to have historically resided in the study area counties; however, the project area is not within its current range of occurrence. Furthermore, according to the Texas NDD (TPWD, 2011b), there are no occurrences of the Louisiana black bear within 1 mile of the Representative Alternatives; therefore, the proposed project would have no effect on the Louisiana black bear.

Ocelot

The ocelot (*Leopardus pardalis*), a federally and state-listed endangered species included within the TPWD (2011a) Annotated County List for Brazoria County; however, this species is not listed as potentially occurring within either of the two counties crossed by the USFWS. The ocelot is considered to have historically resided in the study area counties; however, the project area is not within its current range of occurrence. Furthermore, according to the Texas NDD (TPWD,

2011b), there are no occurrences of the ocelot within 1 mile of the Representative Alternatives; therefore, the proposed project would have no effect on the ocelot.

Red Wolf

The red wolf (*Canis rufus*), a federally and state-listed endangered species included within the TPWD (2011a) Annotated County List for both counties crossed by the project; however, this species is not listed as potentially occurring within either of the two counties crossed by the USFWS. The red wolf historically occurred throughout the eastern half of the state but is now extinct in the wild in Texas, having been extirpated by the 1970s (Schmidly, 2004). Furthermore, according to the Texas NDD (TPWD, 2011b), there are no occurrences of the red wolf within 1 mile of the Representative Alternatives; therefore, the proposed project would have no effect on the red wolf.

West Indian Manatee

The West Indian manatee (*Trichechus manatus*), a federally and state-listed endangered species, is included within the TPWD Annotated County List for Brazoria County; however, this species is not listed as potentially occurring within either of the two counties crossed by the USFWS. The West Indian manatee occurs in coastal waters along the Texas Gulf Coast. Because there are no coastal waters present within the project area, potential habitats for the West Indian manatee would not be present in the project area. Furthermore, according to the Texas NDD (TPWD, 2011b), there are no occurrences of the West Indian manatee within 1 mile of the Representative Alternatives; therefore, the proposed project would have no effect on the West Indian Manatee.

Fish

Smalltooth Sawfish

The smalltooth sawfish (*Pristis pectinata*), a federally and state-listed endangered species, is included within the TPWD Annotated County List for Brazoria County; however, this species is not listed as potentially occurring within either of the two counties crossed by the USFWS. The smalltooth sawfish occurs in coastal waters along the Texas Gulf Coast. Because there are no coastal waters present within the project area, potential habitats for the smalltooth sawfish would not be present in the project area. Furthermore, according to the Texas NDD (TPWD, 2011b), there are no occurrences of the smalltooth sawfish within 1 mile of the Representative Alternatives; therefore, the proposed project would have no effect on the smalltooth sawfish.

Sharpnose Shiner

The sharpnose shiner, a federally listed candidate species, is a small, slender minnow, endemic to the Brazos River Basin in Texas. Historically, the sharpnose shiner existed throughout the Brazos River and several of its major tributaries within the watershed. They generally feed on aquatic invertebrates while also consuming a large amount of sand/silt, which indicates foraging behavior occurs among the sediment, as well as on drift in the water column (Marks et al., 2001). In the

1960s, samples taken from a Fort Bend County location on the Brazos River identified a small population of sharpnose shiners; however, samples taken in the 1990s and 2001 indicated that no sharpnose shiners were present within this portion of their historical range (Center for Biological Diversity, 2002). In another Brazos River study within Fort Bend County, three individuals of sharpnose shiner were collected in the confluence of Allens Creek during September 20–23, 2001 (Gelwick and Li, 2002). Other current information indicates that the population within the Upper Brazos River drainage (upstream of Possum Kingdom Reservoir) is apparently stable, while the population within the Middle and Lower Brazos River Basins may only exist in remnant areas of suitable habitat, or may be completely extirpated (USFWS, 2006). Because the project area is located in the Middle and Lower River Basin area, the presence of the sharpnose shiner within the Brazos River of the project area is not likely. Furthermore, large perennial water sources crossed by the proposed project (Brazos River and Oyster Creek) will be crossed by spanning, and direct impacts to those potential habitats would be avoided; therefore, the proposed project would have no effect on the sharpnose shiner.

Mollusks

False spike mussel

The false spike mussel (*Quadrula mitchelli*) is a state-listed threatened species in Brazoria County, Texas. The false spike mussel is possibly extirpated in Texas, with historic populations in the Rio Grande, Brazos, Colorado, and Guadalupe River Basins (TPWD, 2011a). According to the Texas NDD (TPWD, 2011b), there are no occurrences of the false spike mussel within 1 mile of the Representative Alternatives. Large perennial water sources crossed by the proposed project (Brazos River and Oyster Creek) will be crossed by spanning, and direct impacts to those potential habitats would be avoided; therefore, the proposed project would have no impact on the false spike mussel.

Smooth Pimpleback

The smooth pimpleback (*Quadrula houstonensis*) is a state-listed threatened and federally listed as a candidate species for both counties crossed by the project. The smooth pimpleback is native to the central and lower Brazos and Colorado Rivers with recent observations in 2006 as close as the mainstem Brazos River in Grimes, Waller, and Austin counties (50 CFR Part 17). According to the Texas NDD (TPWD, 2011b), there are no occurrences of the smooth pimpleback within 1 mile of the Representative Alternatives. Large perennial water sources crossed by the proposed project (Brazos River and Oyster Creek) will be crossed by spanning, and direct impacts to those potential habitats would be avoided; therefore, the proposed project would have no effect on the smooth pimpleback.

Texas Fawnsfoot

The Texas fawnsfoot (*Truncilla macrodon*) is a state-listed threatened and federally listed as a candidate species for both counties crossed by the project. The Texas fawnsfoot is native to the Brazos and Colorado rivers in central Texas, with historic populations from Fort Bend County upstream to the lower reaches of the Clear fork Brazos River in Shackelford county (50 CFR Part 17); very few live individuals have been found in recent decades. According to the Texas NDD

(TPWD, 2011b), there are no occurrences of the smooth pimpleback within 1 mile of the Representative Alternatives. Large perennial water sources crossed by the proposed project (Brazos River and Oyster Creek) will be crossed by spanning, and direct impacts to those potential habitats would be avoided; therefore, the proposed project would have no effect on the Texas fawnsfoot.

Reptiles

Alligator Snapping Turtle

The state-listed threatened alligator snapping turtle is the largest North American freshwater turtle species. Alligator snapping turtles inhabit deep rivers, lakes, and large streams of the southeastern U.S. (Garrett and Barker, 1987). Documented records exist from nearby Harris County (Dixon, 2000) and northward, but the species could occur in the project area where suitable habitat exists. The proposed project is not likely to adversely impact any alligator snapping turtle that might be present in the vicinity of the project.

Sea Turtle Species

The five species of sea turtles that, according to the USFWS, that could potentially occur in Brazoria County are the state-listed endangered Atlantic hawksbill sea turtle (*Eretmochelys imbricata*), federally and state-listed threatened green sea turtle (*Chelonia mydas*), federally and state-listed endangered Kemp's Ridley turtle (*Lepidochelys kempii*), federally and state-listed endangered leatherback sea turtle (*Dermochelys coriacea*), and federally and state-listed threatened loggerhead sea turtle (*Caretta caretta*). These sea turtles occur in coastal waters along the Texas Gulf Coast. Because there are no coastal waters present within the project area, potential habitats for the sea turtle species listed above would not be present in the project area; therefore, the proposed project would have no effect on sea turtle species.

Texas Horned Lizard

The Texas horned lizard (*Phrynosoma cornutum*) is a state-listed threatened species that typically occurs in open, semi-arid regions with bunchgrasses that are not present within the study area (TPWD, 2011b). The proposed project will have no impact on the Texas horned lizard.

Timber/Canebrake Rattlesnake

The state-listed threatened timber/canebrake rattlesnake (*Crotalus horridus*) occurs in the eastern third of the state, where it typically inhabits bottomland forests, mesic woodlands, palmetto groves, cane thickets, and brushy fields, especially where dense vegetation grows just above ground level (Werler and Dixon, 2000). The species may occur in the project area in appropriate habitat types; however, no individuals were encountered during the field investigations. The proposed project is not likely to adversely impact the timber/canebrake rattlesnake.

Vascular Plants

Texas Prairie Dawn-Flower

Of the federally listed threatened and endangered plant species in Texas, only one, Texas prairie dawn-flower (*Hymenoxys texana*), is known to exist within the Fort Bend County portion of the Study Area. There are no federally threatened or endangered plant species known to occur in Brazoria County.

The Texas prairie dawn-flower is an annual sunflower (Asteraceae) and ranges in height from 3.5 to 18 centimeters. The bracts conceal the minute ray flowers; the yellow disk flowers are 3 to 4 millimeters long. Texas prairie dawn-flower habitat consists of small, sparsely vegetated areas of fine-sandy saline soil. Competition within these poorly drained depressions is limited due to saline conditions tolerated by the Texas prairie dawn-flower. These sparsely vegetated areas commonly occur on the lower sloping portion of pimple (mima) mounds or on the level to slightly concave areas around the mound's base. Pimple mounds are typically 10 to 50 feet in diameter and less than 12 inches high; the soil is usually sandier than the surrounding flat areas. The Texas prairie dawn-flower is also found in bare spots at locations that endure continuous disturbance over a period of time (e.g., overgrazing), but which have been allowed to revegetate naturally. In the absence of continued disturbance, colonies of Texas prairie dawn-flower are usually out-competed by other vegetation until the continued disturbance resumes and favorable conditions return to the site. The preferred bare spots are usually wet to moist during the winter and early spring but lose all traces of hydrology by summer. These low-lying locations may or may not be considered jurisdictional wetlands. The Texas prairie dawn-flower flowers and fruits from mid-March to mid-April and senescence are usually complete by May (USFWS, 1995). About 50 population sites of this species survive in Fort Bend and Brazoria counties; however, according to the Texas NDD (TPWD, 2011b), there are no occurrences of the Texas prairie dawn-flower within 1 mile of the Representative Alternatives. Due to the potential for occurrence of the Texas prairie dawn in the adjacent proposed Grand Parkway Segment C project area, field surveys were conducted to determine the presence or absence of populations and suitable habitat within the alternative alignments for the proposed project. Ground surveys conducted for the Texas prairie dawn during the flowering period found no populations within alternative alignments. The majority of the study area traversed by the Representative Alternatives and Preferred Alternative consists of improved pasture, agricultural (row crop) fields, woodlands, or developed areas. The proposed project would have no effect to the Texas prairie dawn.

State-Listed Species

Based on a review of the habitat descriptions of each state-listed endangered, threatened, or rare bird species potentially occurring within the study area (see Table 3-22), the following species may potentially occur within the study area at various periods throughout the year: American Peregrine Falcon, Arctic Peregrine Falcon, White-faced Ibis, White-tailed Hawk, Wood Stork, false spike mussel, and alligator snapping turtle. None of the state-listed species have any known documented occurrences within the study area (TPWD, 2011b).

State-listed bird species (American Peregrine Falcon, Arctic Peregrine Falcon, White-faced Ibis, White-tailed Hawk, and Wood Stork) would likely occur within the study area to forage, roost, or migrate through the region. Direct mortality impacts are not anticipated to any state-listed threatened, endangered, or rare bird species as a result of the proposed project.

Other state-listed threatened, endangered, or rare species in Table 3-22 (false-spike mussel and alligator snapping turtle) may be present within the study area; however, their presence would be limited to the bed and banks of perennial water sources such as the Brazos River or Oyster Creek. Because such water sources would be spanned by bridging, direct impacts to these state-listed species are not anticipated as a result of the proposed project. Additionally, potential habitats for the timber/canebrake rattlesnake would be crossed by the proposed project; however, direct mortality impacts are not anticipated as result of the proposed project.

Overall, the proposed project would have no impact on any of the above-listed state species.

Federally Listed Species

Based on a review of the habitat descriptions of federally listed species potentially occurring within the Fort Bend and Brazoria counties, habitat capable of supporting the whooping crane, Sprague's pipit, the sharpnose shiner, and the Texas prairie dawn-flower, smooth pimpleback, and Texas fawnsfoot may be present within the project area. None of the federally listed species above have known documented occurrences within the study area (TPWD, 2011b). Additionally, the Bald Eagle, although delisted, federally is still afforded federal protection under the MBTA and BGEPA. According to the TPWD NDD (2011), three Bald Eagle nests are known to exist within the study area vicinity.

Federally listed bird species (Whooping crane, Sprague's pipit) may occur within the study area to forage, roost, or migrate through the region. Direct mortality impacts are not anticipated to any federally listed threatened, endangered, or candidate for listing bird species as a result of the proposed project. Additionally, the project alignment would not cross in close enough proximity to nest locations of the federally delisted Bald Eagle to interfere with normal breeding, feeding, or sheltering behavior of nesting eagles in the study area and therefore would not "disturb" the Bald Eagle under BGEPA guidelines.

Other federally listed threatened, endangered, or rare species in Table 3-22 (sharpnose shiner, smooth pimpleback, and Texas fawnsfoot) may be present within the study area; however, their presence would be limited to the bed and banks of perennial water sources such as the Brazos River or Oyster Creek. Because such water sources would be spanned by bridging, direct impacts to these state-listed species are not anticipated as a result of the proposed project.

3.18 HISTORIC AND ARCHEOLOGICAL RESOURCES

3.18.1 Cultural Environment

The study area is located in Fort Bend and Brazoria counties, which are within the THC's Southeast Texas Archeological Study Region of the Eastern Planning Region (Kenmotsu and Perttula, 1993). The following discussion of local cultural history is based on the location of the study area within the Southeast Texas Archeological Study Region and more specifically the Brazos River basin and the Coastal Prairie physiographic zone. In general, the Coastal Prairie environment is relatively resource poor, lacking the silicious gravels of the more-inland Outer Coastal Plain and the concentration of food resources that characterize the Coastal Littoral Zone. Although not a severe limiting factor, surface waters within the Coastal Prairie are not as potable as less-clayey inland sources and are not augmented by springs that occur in both Outer Plain and Coastal Littoral environments. Relatively abundant food resources, however, can be found in the riparian hardwood forests that grow along area streams. The habitats associated with oxbow lakes, which currently show up as meander scars and are present within the study area, represent an especially favorable environment for human habitation.

3.18.2 Prehistoric Period

The earliest generally accepted culture of the Americas, the Paleoindian, ranged over most of North America by the close of the Pleistocene. Several types of well-made, lanceolate projectile points diagnostic of this culture, including Scottsbluff, Clovis, Plainview, and Angostura, and possibly San Patrice, have been recovered from archeological contexts in the vicinity of the study area. The sites in the study area vicinity yielding this information include 41HR5 and 41HR7 (Wheat, 1953), and 41HR85 (Aten et al., 1976).

Evidence is scarce of the Early Archaic cultures. Aten (1983) sees a continuation during the Early Archaic of a generalized technology and minimum band level of social organization established during the Paleoindian period. Dart points that suggest Early Archaic activity in this area are primarily central Texas types, including Baird, Bell, Andice, and Wells points.

At sites dating to the Middle Archaic, more regional variation in artifact assemblages has been noted (Aten, 1983). The potential for occupation of the study area before and during the Middle Archaic is felt to be low, except between 2000 B.C. and A.D. 1000 when Oyster Creek Meander Belt was active. Along the Brazos River at the inland boundary of the Coastal Prairie (Hall, 1981), a variety of both central and east Texas point types occur, including Bulverde, Trinity, and Carrollton points.

The Late Archaic extends from the approximate period when the sea level attained its current state until the introduction of the bow and arrow along the Brazos River in ca. A.D. 900 (Hall, 1981). Regional cultural variations, and possibly population as well (Fields et al., 1983), are greatest during the Late Archaic. Aten (1983) cites Story (1980) in her recognition of two broad adaptive patterns that coexisted within different geographic regions of east Texas during the Late Archaic. The pattern that may be applicable to the study area and to the preferred alternative is Story's eastern strategy, which "was designed for the humid woodlands and prairies of the upper coast," and included a seasonal round with group dispersal in

coastal areas during the summer and consolidation in inland areas in the winter months. The systematic exploitation of coastal resources increased the potential for occupation of the study area, most likely by groups based along the Brazos River. Projectile points diagnostic of Late Archaic occupations are the eastern types, Gary, Kent, Yarbrough, and Ellis, but also include Palmillas and Refugio types characteristic of the Coastal Bend (Patterson, 1979).

The Late Prehistoric period is a time of relatively static environmental conditions that lasted until European contact. Population during the Late Prehistoric tended to increase until European-introduced disease decimated the aboriginal inhabitants. Patterson (1979) observed an increase in numbers of Late Prehistoric sites while individual sites exhibited fewer cultural remains. He interprets this as evidence of a more mobile lifestyle. Projectile points diagnostic of Late Prehistoric occupations include Perdiz and Scallorn, and ceramics may include Goose Creek Plain variety Anahuac, O'Neal Plain variety Conway, Mandeville Plain, Tchefuncte Plain, Goose Creek variety unspecified, and Tchefuncte Stamped, for the earlier part of the period, and San Jacinto Incised and Baytown Plain, varieties Phoenix Lake and San Jacinto (Aten, 1983). It should be noted that these ceramic sequences were developed for the Galveston Bay area and may or may not apply to any archeological remains in the study area.

The Historic Indian period occupation of the project vicinity by aboriginal people has been previously described by Wheat (1953) and Fields et al. (1983); therefore, further elaboration will not be made at this time. However, it is important to note that Aten (1983) places this area within a buffer zone between the known territories of the Coco, Akokisa, and Tonkawa, and occupation of the study area by these groups could have been possible.

3.18.3 Historic Period

The historic period for the area now known as Fort Bend and Brazoria counties and the vicinity of the proposed Grand Parkway Segment C Preferred Alternative begins with Cabeza de Vaca's account of his survival as a member of the ill-fated Narvaez expedition of 1527. Marooned by a hurricane that destroyed the fleet, Cabeza de Vaca and a handful of companions are believed to have landed at the mouth of Oyster Creek during their journey to find the Spanish colonies in Mexico. Cabeza de Vaca is said to have remained in the area for a while and traveled with the local native groups up and down Oyster Creek (Wharton, 1939). The area remained under Spanish control, occupied by native groups and only a few remote Spanish missionary and military outposts, until the early nineteenth century when Mexico established its claim to the region. Occupation of this region by Native American groups was limited, although areas on either side of Big Creek were a favorite campground for local groups. This area is noted to have been within a buffer zone between the known territories of the Coco, Akokisa, and Tonkawa, suggesting occupation by any of these groups at some time may have been possible (Aten, 1983).

In the early decades of the nineteenth century, Anglo-American immigration into this area began under the leadership of *empresario* Stephen F. Austin, who was empowered by the Mexican government to promote settlement and grant lands in the fertile Brazos River Valley. Native groups were not prevalent around the Brazos River at this time, although occasional encounters with them did occur. The Brazos River was too far south and east for the Comanches, and only a single camp

of Karankawas was known to be located on Big Creek, about 15 miles below the town of Richmond. Colonization by Stephen F. Austin's "Old Three Hundred" began when the first of the settlers were dropped off at the mouth of the Brazos River in January of 1822. They then traveled upriver to a large bend in the Brazos River, where the City of Richmond is currently located, and constructed a log shelter known as the "Fort." Each of the Old Three Hundred settlers was granted a league and a labor of land by the Mexican government in 1824 (Wharton, 1939). They established homesteads along the fertile agricultural lands of the Brazos River, along the banks of Big Creek to the south, and along Oyster Creek to the east. The earliest houses were of hand-hewn logs, typically two rooms in size with an open central hallway known as a "dog run." Although Stephen F. Austin's father, Moses Austin, envisioned the colonists developing commercial-scale agriculture based on sugar and cotton as the principal crops, corn was the crop raised initially as subsistence for the families and their livestock. After 1824, the Mexican government authorized the granting of additional lands, and more settlers continued to arrive.

As settlers moved into the area, there were two recorded encounters with the Karankawas living along Big Creek in Fort Bend County. A significant event in local history was the "Big Creek Campaign" in 1824. Several Karankawas were pursued in retaliation for stealing some horses (Wharton, 1939). Another battle with Karankawas occurred on Jones Creek in adjacent Brazoria County in 1824. As more settlers arrived, typically from the deep southern states of the United States (Jordan et al., 1984), a cotton gin, general store, and trading post were established at Richmond. A ferry also operated across the Brazos River at Thompsons Crossing.

During this period, cotton was grown as a commercial crop. Sugar was also cultivated, but on a more experimental level by relatively few farmers (Creighton, 1975). Although the Mexican government prohibited the importation of slaves from Africa, both cotton and sugar cultivation required intensive labor commitments throughout most of the year. To meet the labor requirements, some of the more wealthy planters brought slaves into the region when they originally settled there. The prohibition against importation of slaves was flagrantly violated by several of the larger cotton growers who participated in the illicit slave trade (Wharton, 1939).

Growing resentment toward the Mexican government's control over the settlers stirred revolutionary sentiments. Recommendations for Texas's declaration of independence emanated from the towns of Columbia and Brazoria in the months before the Mexican army began its advance into Texas (Creighton, 1975). When news of the massacres of Texan forces at Goliad and San Antonio reached Austin's colonies, many local residents abandoned their homesteads and fled eastward in an event known as the "Runaway Scrape." Some individuals hid in the woods along the way, while others fled as far as Louisiana (Wharton, 1939).

In April 1836, General Santa Anna and his Mexican troops left San Felipe and traveled south to a homestead near present-day Kendleton on Turkey Creek. From there he marched to the Thompsons ferry on the Brazos River. He captured the ferry, the west side of the river, and ransacked and burned every house in Richmond. Santa Anna then divided his troops, taking only a portion of them to Harrisburg. The remaining troops were left to camp in the river bend at

Richmond for 3 days. Santa Anna's defeat and capture at San Jacinto left the rest of his Mexican force to retreat by way of Turkey Creek (Wharton, 1939).

After the Texans' victory over Santa Anna, Austin's colonies experienced a period of tremendous growth and prosperity. Many new towns were established; Fort Bend and Brazoria counties were formed with Richmond and Brazoria as their respective county seats. The defeat of Mexican rule also enabled the open practice of non-Catholic religions, which in turn led to the establishment of numerous churches.

In the period between the Texas Revolution and the Civil War, sugar quickly became the dominant cash crop, and large sugar plantations using slave labor developed along the banks of the Brazos River and Oyster Creek. As the plantations prospered and expanded their production, small sugar mills were quickly replaced by larger steam-powered mills. Within the current project vicinity, Francis Bingham and Sterling McNeel each had large brick sugarhouses that served the Bingham and Darrington plantations as well as other local planters. Early accounts document that sugarcane was brought in from the field by slaves using horse-drawn carts and in some cases on small rail cars (Armstrong, 1991).

Prior to the arrival of commercial rail transportation, the Brazos River not only provided fertile land for cultivation, but also provided a vital means of transporting crops to market. Steamboats regularly traveled the Brazos River with cargoes of cotton and sugar. Landings were located at plantations in Big Creek, Waters, Richmond, Gaston, and Randoon. However, a bar at the mouth of the Brazos River sometimes hindered transportation, and steamers began to abandon the Brazos River in favor of Buffalo Bayou and the growing town of Houston. Efforts to improve navigation on the Brazos River were made in the 1850s. The Galveston and Brazos Navigation Company secured a charter to construct a canal from the mouth of the Brazos River to West Galveston Bay. This canal was dug by hand and was completed sometime between 1854 and 1857 (Meyers, 1998).

The first chartered railroad in the area was built from Harrisburg to Richmond through Sugar Land. It was chartered in 1850 and was called the Buffalo Bayou, Brazos and Colorado Railroad. In 1856, the Houston Tap and Brazoria Railway Company was established. Nicknamed the "Sugar Road" or the "Sugar Land Express," this railway ran east of the Brazos River along Oyster Creek, stopping at various plantations, including the Darrington and Bingham plantations, along the way. It was later purchased by Missouri Pacific, which eventually abandoned the line south of Arcola. The abandoned line was still noted, however, on both the 1963 Juliff and 1953 Thompsons USGS 7.5-minute quadrangle maps.

In order to secure certain economic and political advantages, Texans voted to join the United States in 1845. However, by 1861, amid increasing tensions between northern and southern states, the residents of Fort Bend and Brazoria counties strongly favored secession as a way to preserve their cultural and economic interests. Locally, Terry's Texas Rangers was formed under the direction of Colonel B.F. Terry. Many men from Fort Bend and Brazoria counties joined the Confederate districts of Texas, New Mexico, and Arizona, headquartered in Houston. The 26th Texas Calvary and other regiments were camped outside Richmond for purposes of patrolling the Brazos River. Confederate blockade-runners also operated on the Brazos River, exporting cotton and sugar in exchange for supplies to support the Southern war effort.

The end of the Civil War marked the beginning of a difficult time for the people of Fort Bend and Brazoria counties. The federal government seized crops and Texas was placed under military rule with federal troops camped at Velasco and Sandy Point (Creighton, 1975). When local slaves learned of their emancipation on June 19, 1865, more than a year after President Lincoln had proclaimed their freedom, many of the former slaves had few options but to stay on at the plantations and work for meager wages or a share of the crop. Continued black settlement on the Levi Jordan Plantation in Brazoria County is one documented example of this type of by former slaves during the postbellum period (Brown et al., 1974; Brown and Cooper, 1990; Freeman, 2004). Others moved into small ethnic enclaves, often on the land of a failed plantation, and eventually developed self-reliant communities with their own churches and schools. However, most former slaves left the rural plantations and moved into developing "Freedmen" communities in and around major market centers, like the Fourth Ward of Houston.

In the Reconstruction years, many former plantation owners were forced to subdivide their land into smaller parcels and offer them either for sale or lease as a means to recover some of their lost investment and to generate income. Over time a viable postbellum pattern of agriculture developed that included several variations on the theme of smaller-scale farms operated by individuals or single-family units. One of these variations came to be known as sharecropping because the landowner provided housing, tools, and grain for planting in exchange for one-half to two-thirds of the crop produced by the sharecropper, an individual who was often a former slave of the landowner. Another variation, called tenant farming, required that the tenant be somewhat better off financially and thereby able to provide his own tools and grain (Moore, 2001). Under tenant farming, the landowner was usually paid a fee at harvest time for leasing the land to the tenant. Certain plantation owners were known to abuse their position by evicting the sharecroppers or tenants at harvest time and seizing all of the crops (Wharton, 1939).

Gradually, sharecropping and tenant farming in the Reconstruction period developed into a pervasive system that continued well into the late nineteenth and early twentieth centuries. However, another agricultural system that more closely resembled the antebellum pattern of forced gang labor also developed during Reconstruction to cultivate large tracts of land. In an attempt to address agricultural labor shortages, the state instituted a program in 1871 that allowed for the leasing of imprisoned convicts as farm laborers on large private plantations (Armstrong, 1991; Wharton, 1939). The convicts were also leased out to construct railroads. This system worked so well that in 1886 the legislature authorized the state's penitentiary system to purchase farmlands and operate them with convict labor. This was the beginning of the Texas prison farm system. Many of the state's prison farm units are located in Fort Bend and Brazoria counties, including the Darrington Prison Farm within the proposed Grand Parkway Segment C Preferred Alternative.

The Darrington State Prison Farm, formerly known as the Darrington Plantation, was one of the old plantations acquired by the state under the prison farm program. The land was initially granted to Achilles McFarland, one of Austin's Old Three Hundred settlers, but later became a large sugar plantation owned by Sterling McNeel. Years later, in his early-twentieth-century recollection of Brazoria County's most prominent plantations, Strobel (1926) describes the Darrington Plantation as having slave cabins and a large main residence, as well as a brick sugarhouse with a double set of kettles. According to

Strobel's account, pre–Civil War improvements had long since disappeared from the plantation. The Houston Tap and Brazoria Railway at one time ran through the plantation/prison en route to Sugar Land. According to Jimmy Hawkins (2001), Farm Manager of the Darrington Prison Farm, the rail line carried inmates to the various prisons. The remains of it today can be seen as a dirt road running through the farm.

To a great extent, the success of Reconstruction in the South was dependent on the rebuilding and expansion of rail transportation, particularly in areas of agricultural production. For Brazos River farms and ranches, rail connections to Houston and Galveston were of vital importance. In 1867 a yellow fever epidemic in Galveston caused the City of Houston to prohibit rail service between the two cities. With the realization that this embargo was an asset to the Port of Houston, subsequent embargoes were imposed. In order to survive, the City of Galveston built the Gulf, Colorado and Santa Fe Railroad to bypass the City of Houston. This line came under the control of the Atchison, Topeka, and Santa Fe Railroad in 1886, which is now part of the Burlington, Northern and Santa Fe Railroad that still operates today. Starting in the 1880s, railroad promoters and land speculators brought German, Irish, Czech, and Polish immigrants to the area. These immigrants established small farmsteads across the area and founded numerous ethnic communities. Fairchild, Needville, and Guy are each examples of the type of small rural farming communities founded in the late nineteenth and early twentieth centuries along the rail lines. Another such community at the eastern end of the proposed Grand Parkway Segment C Preferred Alternative is Iowa Colony.

While cattle ranching had long been an integral part of agricultural operations in Fort Bend and Brazoria counties, the introduction of barbed wire and selective breeding practices in the 1880s gave ranchers better control over their cattle and allowed them to increase the size and quality of the herds. Several meat-packing plants were constructed in the area, and as railroads were established, ranchers began to ship their cattle to market by rail. The hurricane of September 1900 that destroyed Galveston also devastated farms and communities across much of Fort Bend and Brazoria counties. Although many people lost their lives and their livelihoods in the storm, people quickly began to rebuild, and the early twentieth century became a time of prosperity for Fort Bend and Brazoria counties. Cars, electricity, and telephone service were introduced to the counties. Land speculators attracted new immigrants, and new communities were formed.

The region's economy began to change with the advent of oil and mineral extraction. Shortly after substantial oil and gas deposits were discovered at Spindletop and Galveston Bay, sulfur was discovered at Bryan Mound in 1901. Subsequent sulfur discoveries in the area include Big Creek Community (1922) and the Orchard Dome (1924). By 1928, the Gulf Coast of Texas was producing over 90 percent of the world's consumption of sulfur. None of these finds are within the preferred alternative.

In response to increasing mineral exploitation, the Damon branch of the Gulf, Harrisburg, and San Antonio Rail line was constructed from Rosenburg through Damon in 1917. In 1931, the Thompsons branch of the Gulf, Colorado and Santa Fe Railroad was constructed from Thompsons southwest to Cane Jet, and joined with the Atchison, Topeka, and Santa Fe at SH 60 just below Wharton. This may have been a Works Progress Administration project. Both rail lines were abandoned in 1985.

During World War I, the demand for sulfur greatly increased and production levels increased accordingly. Local participation in the war effort included the formation of local home guard units. Draft boards were formed and men were selected to join the service. Company D, 5th Texas Infantry was organized in Brazoria County and deployed to France. Federal troops were sent to guard the sulfur plant at Freeport. Coincident increases in shipbuilding also raised the demand for live oak treenails, wooden pegs used in shipbuilding at the time. Brazoria County factories located at Brazoria, Sweeney, and Hasima were the primary source of this product, much of which was used at Texas's shipbuilding centers at Galveston and Orange.

The demand for sulfur decreased with the end of World War I, and oil exploration became more profitable. Although the first oil gusher in Brazoria County occurred in 1902, a long and prosperous series of discoveries was made after the war. A complete listing of local oil fields includes Blue Ridge (1919), Big Creek Fields (1922), Orchard Field (1926), Sugar Land Field (1927), Long Point (1924), Clodine (1929), Thompsons (1931), Katy (1935), and Needville (1941). The oil boom brought a surge in population and was good for the local economy.

In the project vicinity, the Thompson Oilfield was discovered on the Jones Plantation in the 1920s. Originally founded by one of Austin's Old Three Hundred colonists, Henry Jones's plantation survived the Civil War as a combined cattle-ranching and farming operation that was less dependent on slaves for labor and financial collateral. By the time of the oil discovery, the operation had been passed down from Jones through a series of heirs and was known as the George Ranch. While oil provided a substantial portion of the family's wealth, much of which was used for philanthropic pursuits, the George Ranch continued its traditional interests in farming and ranching, albeit in a modernized manner greatly differing from the ranch's antebellum origins. By the 1920s, a substantial portion of the George Ranch was being farmed by tenants who leased houses and attended a school that belonged to the George Ranch. A significant and distinctive collection of surviving tenant farmhouses, set amid an expansive agricultural landscape extending east to the Brazos River, was recognized and avoided along FM 762 during the initial route selection process for the proposed Grand Parkway Segment C.

By 1928, rice farming had become an important industry in the Brazoria-Fort Bend area, and the Richmond rice canal system was constructed. At Crabb Switch, a local stop along the Gulf, Colorado and Santa Fe Railway, a large rice drying, storage, and shipping facility developed to serve local area rice growers. Located within the original Joseph Kuykendall Survey, this agricultural industrial facility and its associated general store were both recognized and avoided during route selection for the current project.

During the 1930s, the Great Depression had substantially less of an impact upon the Texas Gulf Coast than elsewhere, although a significant drought made grain prices prohibitive, which in turn made it difficult for farmers to feed their herds. As a result, the quality of cattle was poor, and buyers for the United States government purchased starving cattle and sent them to the Houston Cattle Company in Missouri City for slaughter. There the company boned, processed, cooked, and canned the beef to help feed the destitute.

During the 1940s, local area residents again contributed to the war effort. Local militia groups were formed to protect the home front. Farming and manufacturing, as well as oil and mineral production, were increased in response to the war effort. A prisoner of war camp was established in Richmond to house German, Italian, and Japanese prisoners who were expected to work within the local community. Following locally familiar prison-farming practices, a Fort Bend County family could hire up to 10 prisoners at a time to help with planting and harvesting. Rice farmers paid prisoners 40 cents a hour for 10-hour days. The farmers provided the transportation and the U.S. Army provided the guards and food. Prisoners also worked at the meat-packing plants and built the Clodine rice dryer. Other structures in the area may have also been constructed by the prisoners of war. In Brazoria County, prisoner of war camps were located at Camp Angleton and Alvin, supplying cheap labor to the communities there as well.

3.18.4 Archeological Resources

Archeological Resources

Various laws and regulations require consideration of the impacts of the proposed project on cultural resources such as archeological sites and historic structures. TxDOT operates under several formal agreements that expedite its compliance with these laws and regulations.

Not all cultural resources are afforded equal treatment in the planning process under applicable cultural resources laws. Historic (NRHP-listed or -eligible) properties and State Archeological Landmarks (SALs) are those objects, sites, and structures that have characteristics that require those resources to be given further consideration in the project planning process. Projects should avoid and minimize impacts to historic properties and SALs when possible. They should resolve the effects of impacts, usually through some mitigation measures, when avoidance is not possible.

Consideration of possible impacts to cultural resources is required under the Antiquities Code of Texas because the project is being planned as a public transportation facility with TxDOT. Cultural resource impacts must also be considered under Section 106 of the National Historic Preservation Act, as amended, because the project is being planned with federal funding provided by the FHWA. The purpose of the intensive survey was to identify NRHP-eligible sites within the existing and proposed ROW for the proposed Grand Parkway Segment C Preferred Alternative and involved archival research and fieldwork conducted in 2001 and 2003 under Texas Antiquities Permit No. 2553.

The investigations (as discussed in Section 3.18 and 4.18) were performed in compliance with the National Historic Preservation Act of 1966 (Public Law [PL] 89-665), as amended in 1974, 1976, 1980, and 1992; the NEPA of 1969 (PL 91-190. 83 Stat. 915, 42 USC 4321, 1970); the Procedures of the Advisory Council on Historic Preservation (ACHP) (36 *Code of Federal Regulations* [CFR] 800); and other appropriate cultural resources legislation and guidelines, as well as the guidelines set forth by the Register of Professional Archaeologists and the Council of Texas Archeologists.

3.18.4.1 Previous Archeological Investigations

Numerous cultural resource management studies have been conducted in Fort Bend and Brazoria counties, including large-scale archeological surveying, testing, and mitigation conducted in association with the construction of Barker and Addicks reservoirs. Reviews of previous research along the upper Texas coast have been presented by Aten (1983), Fields et al. (1983), and Stokes (1985). In addition, Moore et al. (1989) and Patterson (1995) have compiled extensive bibliographies for the archeology of this region. This section briefly summarizes previous archeological investigations in the region through the Grand Parkway Segment C surveys in 2003.

The earliest professional investigations in the upper Texas Gulf Coast region were conducted by J.E. Pearce under the sponsorship of the Bureau of American Ethnology. Between 1918 and 1932, Pearce, then Chairman of the Department of Anthropology at the University of Texas, conducted or directed numerous reconnaissance and excavation projects throughout East Texas (Pearce, 1932). Pearce seems to have been largely concerned with the relationship between Texas cultures and the high cultures of the Mississippi Valley, the American Southwest, and Mesoamerica, as well as the role of eastern Texas as a route for diffusion between these cultures. His interest in the upper coast area must be considered somewhat marginal. With the exception of excavation at the Caplen site, a prehistoric cemetery in Galveston County, little of his investigations in the region were ever published (Campbell, 1957).

Addicks Reservoir

The next major investigation in the vicinity of the study area and the proposed Grand Parkway Segment C Preferred Alternative was conducted in Addicks Reservoir for the Smithsonian Institution River Basin Surveys by Joe Ben Wheat (1953). Wheat conducted surveys in the late 1940s, along Langham, South Mayde, and Bear creeks and Buffalo Bayou recording nine archeological sites. Wheat performed excavations at several sites where he obtained data that resulted in the development of a chronological sequence for the area based on lithic typology (Suhm et al., 1954).

Considerable research effort has also been expended in the Addicks area by members of the Houston Archeological Society. Numerous surveys and excavations conducted by the Houston Archeological Society have contributed to our understanding of prehistoric settlement patterns, chronology, and technological change (Patterson, 1972, 1973a, 1973b, 1974, 1975, 1976, 1977, 1980a, 1980b). Most of this information has been published in the *Houston Archeological Society Newsletter*.

A comprehensive investigation conducted in this area was a survey in Addicks Reservoir, conducted under the auspices of the Cullen Foundation for the City of Houston (Fields et al., 1983). In the course of this investigation, Fields et al. surveyed all high-site-probability areas and sampled low-probability areas (1983). They investigated 46 prehistoric and 18 historic sites. The preferred location for historic settlement was found to be in upland situations, while all but two of the prehistoric sites were confined to pimple mounds in the floodplains (Fields et al., 1983).

Shortly after the completion of the Addicks Reservoir survey, Prewitt & Associates, Inc., was contracted by the USACE to perform a survey at Bear Creek Park, which lies within Addicks Reservoir. This investigation included the survey of approximately 37.8 percent of the 2,920-acre park and resulted in the recording of five prehistoric and seven historic sites. Three of the prehistoric sites were found to be clustered in a group of at least 26 natural pimple mounds. The fourth site is located on a relatively isolated pimple mound, while the fifth is on an upland margin. Two of the prehistoric sites provided temporally diagnostic artifacts, which suggested occupation during the Early and/or Late Ceramic periods. The remaining sites yielded only nondiagnostic lithic debitage (Howard and Freeman, 1983).

In early spring 1983, one of the sites (41HR436) recorded during the Addicks Reservoir survey was tested (Kotter and Fields, 1983). The testing was directed toward the assessment of the site's eligibility for the NRHP. Site 41HR436 is one of only a few known upland prehistoric sites in Addicks Reservoir. The site was recommended for nomination to the NRHP (Kotter and Fields, 1983) and was nominated by the USACE Galveston District.

Another archeological investigation within Addicks Reservoir was a survey for improvements to Eldridge Road (Voellinger and James, 1984). Two sites previously reported by Fields et al. (1983) (41HR473 and 41HR188) were revisited, but no additional cultural resources were identified.

Barker Reservoir

Texas A&M University conducted a survey in 1983 on portions of Barker Reservoir, where a total of 17 archeological sites were recorded. Of those sites, 5 are historic and 12 are prehistoric. Ten of the 12 prehistoric sites are located on pimple mounds or terrace remnants (Ensor et al., 1987).

Other work by Texas A&M in Barker Reservoir included an additional archeological survey and test excavations (Ensor et al., 1987). The archeological survey resulted in the location of five prehistoric sites and one historic site. The prehistoric sites are all located on small pimple mounds in the floodplain. They were found to contain information potentially significant to area prehistory. The historic site, a twentieth-century farmhouse, was not considered to be eligible for the NRHP.

This survey was followed by the NRHP eligibility testing of three of the sites recorded during the survey: 41FB70, 41FB71, and 41FB72 (Ensor et al., 1987). Two of these sites (41FB71 and 41FB72) were found to contain cultural materials relating to the Late Archaic or Early Ceramic and Late Ceramic periods. The third site, 41FB70, exhibited material relating to a Late Ceramic period of occupation. All three sites were recommended for nomination to the NRHP and were subsequently excavated and reported by Ensor in 1987.

Additional inventories and assessments of cultural resources were conducted at Barker Reservoir (Fields et al., 1986). This work included a survey of 3,122 acres along the floodplains of Buffalo Bayou and its tributaries, as well as 1,293 acres in the adjacent uplands. During this effort, 31 prehistoric and 21 historic sites were documented. All of the prehistoric sites were located on natural rises and mounds on the floodplain of Buffalo Bayou.

Other Work

The Texas Archeological Survey of The University of Texas at Austin conducted an archeological survey along Clear Creek pursuant to a flood control project in Brazoria County. This effort located 76 prehistoric sites and 2 historic sites (McGuff and Cox, 1973).

Following the Clear Creek survey, a comprehensive investigation within the East Texas Coastal Plain was reported by Hall (1981). In 1974 and 1975, investigations of 15 archeological sites were conducted in Austin County along Allens Creek, a tributary of the Brazos River approximately 115 kilometers from the Gulf Coast. Excavations at one site, 41AU36, revealed 236 burials that could be segregated into four cemeteries, dating from the Middle Archaic through the Late Prehistoric period.

In November and December 1983, an archeological survey of the First Colony Levee Improvement District (LID) was conducted (Scott and Freeman, 1984). Four historic sites and one prehistoric site were recorded during the survey and a previously recorded prehistoric site was also revisited. All of the newly recorded prehistoric sites were located on the Oyster Creek floodplain, most on low rises or pimple mounds. Further archival research and informant interviews were recommended for the four historic sites to adequately assess them in terms of the NRHP eligibility. The prehistoric sites were not considered eligible for the NRHP, and no further work was recommended. In early spring 1984, a second phase of the cultural resource work of the First Colony LID was conducted (Ragsdale and Fields, 1984). This phase, a historical assessment, consisted of an informant, archival, and literature search as well as an architectural evaluation on one historic site. As a result of the records search, the location of a cemetery and a turn-of-the-twentieth-century farmstead, as well as the probable locations of a second earlier farmstead and a plantation, were identified. However, only the farmstead and the cemetery could be located in the field. Neither of these sites, nor the locations of the earlier farmstead and plantation, were judged to be eligible for the NRHP.

The USACE, Galveston District conducted an archeological survey along Oyster Creek and located five prehistoric sites (Good, 1985) in oxbow cutbank exposures and plowed portions of floodplain rises. A historical and archeological assessment for the Sienna Plantation development was conducted in summer 1984 (Glander, 1984). One prehistoric site and several historic structures relating to the plantation era were documented. A cultural resources survey of the 1,300-acre Riverbrook Associates property was conducted during 1986, which identified eight previously unrecorded sites—seven historic housesites and one disused cemetery (Hudson, 1986).

During January and February 1986, the NRHP testing was conducted on site 41FB99, the Flat Bank Creek site, located along a channel of the Oyster Creek meanderbelt. The testing program revealed midden deposits and several pit features. Radiocarbon dating and artifact analysis indicated that the site was occupied between about A.D. 800 and 1600. An earlier preceramic component was possibly present as well. Due to the site's considerable research potential, it was judged to be eligible for the NRHP (Kelly et al., 1994).

During spring 1987, an archeological survey of Cinco Ranch identified one historic site and four prehistoric sites (Voellinger et al., 1987). The four prehistoric sites were later subjected to a program of archeological testing designed to determine their NRHP eligibility status. The testing revealed that three of the sites contained substantial quantities of buried cultural debris and were therefore potentially eligible for the NRHP. The fourth site, however, yielded no artifactual remains during the testing phase of the project and thus did not contain enough retrievable information to warrant the NRHP nomination.

An archeological survey of Natchez, a 1,200-acre development in Fort Bend County, was conducted in late fall 1987 and winter 1988 (Voellinger et al., 1988). As a result of that survey, 15 previously unrecorded cultural resource sites were located: 13 historic sites, 1 prehistoric site, and 1 multicomponent historic/prehistoric site. The prehistoric components appeared to offer scant cultural deposits and were not likely to yield significant information. Of the historic components, one site was thought to be related to an early-nineteenth-century occupation. A second site, an industrial site, appeared eligible for the NRHP due to its direct association with the development of rice farming, an important trend in the local history. The remaining historic sites appeared to be related to the sharecropper occupation of the area.

A survey was conducted of the Joseph S. and Lucie H. Cullinan Park (Moore and Moore, 1991). Data recovery was eventually conducted (Moore et al., 1996) at two prehistoric sites (41FB199 and 41FB200) located during the original survey of the park.

Survey and trenching (Sherman, 1998) and data recovery (Rogers et al., 2000) were conducted at site 41FB255, a Late Prehistoric site located on a natural levee of an abandoned channel of Oyster Creek. This site appears to represent multiple occupations during the Late Prehistoric period. Seven radiometric samples were submitted with returned dates ranging between A.D. 979 and 1598. This project also conducted a DNA study, which was the first time any DNA had been sampled and tested from prehistoric human skeletal remains from Texas (Rogers et al., 2000).

Data recovery was conducted at old Velasco (41BO125) (Earls and Tomka, 1994) at the mouth of the Brazos River. Previous work conducted at 41BO125 includes that conducted by Fox et al. (1981). This effort also included research on the Quintana site of the Brazos River. An archeological survey of the Quintana Beach County Park included the reassessment of site 41BO116 (Corbin, 1987).

Archeological excavations were conducted at the Varner-Hogg Plantation State Historical Park in Brazoria County (Earls and Tomka, 1994). Earlier work conducted at the park examined the historic occupation of the plantation and included the documentation of building foundations and construction monitoring (Crouch, 1982).

Other investigations within the two counties include a cultural resources survey of an 18-acre development project on Clear Creek in Brazoria County, which assessed the integrity of prehistoric site 41BO182 (Moore, 1994); a survey along a proposed pipeline corridor in the Brazoria National Wildlife Refuge, which yielded negative results (Booth et al., 1994); and a cultural resource survey of a well pad in Brazoria County, also yielding negative results (Moore et al., 1996). Numerous

other surveys, typically limited in size and scope, have been conducted in the area by the USACE. These reports are on file as letter reports at the THC.

Reconnaissance survey, archival research, and informant interviews for the proposed Grand Parkway Segment C were conducted previously in 1999 (Sherman et al., 2003) to assess archeological high-probability areas (HPAs) within the Universe of Alternatives and identify any cultural resource sites through their surface expression. This work resulted in the identification of four newly recorded archeological sites (41FB271, 41FB272, 41BO203, and 41BO204). Of these sites, only 41FB272 is located within the proposed Grand Parkway Segment C Preferred Alternative. Five previously recorded sites (41FB114, 41FB127, 41FB128, 41FB133, and 41FB134) were also visited and assessed based on surface expression. Of these sites, only 41FB127, 41FB128, and 41FB134 are located within the proposed Grand Parkway Segment C Preferred Alternative. All three of these are historic sites have been negatively impacted by suburban encroachment.

3.18.4.2 Recorded Archeological Site Locations

At the time of the official archeological records review (1999), approximately 32 previously recorded archeological sites had been recorded within the study area. Most of the known site locations were identified from the official site file records at the Texas Archeological Research Laboratory (TARL), which revealed more than 190 previously recorded archeological sites in Brazoria County and more than 250 sites in Fort Bend County. In Brazoria County, nine sites were NRHP listed, two were determined eligible for the NRHP, and eight were identified as SAL properties. In Fort Bend County, the NRHP and the SAL publications each listed two sites. None of the NRHP or SAL properties were located in the study area, and none were located within the final proposed Grand Parkway Segment C Preferred Alternative because all such sites had been avoided through project planning and design adjustments. Of the 32, Several previously recorded archeological sites for which the NRHP eligibility determinations have not been made are located within the proposed Grand Parkway Segment C Preferred Alternative. These include historic sites 41FB127, 41FB128, and 41FB134, and prehistoric/historic site 41FB272. All four of the historic and prehistoric/historic sites have been negatively impacted by suburban encroachment.

3.18.4.3 Reconnaissance Survey of High-Probability Areas

In addition to these approximately 32 previously recorded archeological site locations, it was recognized that the study area likely contained other archeological sites of potential historical significance. To assess the potential for locating additional archeological resources, efforts were made to predict and ground-truth accessible areas with a high probability for locating additional archeological sites. HPAs for prehistoric and historic cultural resource sites were predicted using 7.5-minute topographic maps of the study area and available soils data. The HPAs were defined as areas in proximity to major drainage areas, on natural levees, and in proximity to previously recorded cultural resource sites. Previous research has shown that the majority of the previously recorded prehistoric sites in this region are located on rises within floodplain

settings. Historic sites are located within both floodplain and upland settings. The field reconnaissance to ground-truth the HPAs was limited to accessible tracts within the study area.

About one-third of the HPAs examined are located in the Brazos River Valley in areas where fluviate and deltaic deposits date to the Holocene. The bordering upland areas represent older Late Pleistocene, fluviate and deltaic deposits that predate human occupation in the region. Previous archeological investigations in the region have demonstrated that historic and some prehistoric sites exist in upland regions. It was expected that sites located on older geological landforms would not be found in deeply buried contexts. For this reason, upland prehistoric sites were expected to be found close to the ground surface. Likewise, historic sites in upland areas were expected to be found close to the ground surface. The integrity of these sites most probably would depend on the range of historic transformations to which they have been subjected, such as agricultural and housing development.

The portion of the study area that is located within the Brazos River floodplain has the potential to contain deeply buried archeological sites. Previous research has demonstrated that sandy floodplain rises located in areas where Holocene deposits outcrop, such as natural levees and pimple mounds, have a high probability of containing prehistoric sites, some of which could be deeply buried and maintain a high degree of integrity. A high occurrence of historic sites was not expected for such landforms. However, if such sites are located there, it was expected that they could maintain a high degree of integrity. Floodplain settings not on rises were considered to have some potential for containing cultural resources. However, identification of buried sites in this setting was hampered because such areas were obscured by dense clay at the ground surface, as observed during the field reconnaissance.

To ground-truth the predicted HPA predictions, a complete pedestrian walkover of accessible portions of each HPA was undertaken in 1999 (under Antiquities Permit 2173). Two archeologists traversed each HPA two times following a serpentine pattern to search for surficial evidence of cultural occupation. Particular attention was paid to areas where the ground surface was visible, such as roadcuts, rodent burrow spoil piles, cut banks, treefalls, cattle trails, and dirt roads.

Five previously recorded sites were revisited and four cultural resources sites were newly recorded during the reconnaissance survey. Together, the previously recorded and newly recorded archeological site locations amounted to a total of 32 recorded site locations within the study area at the conclusion of the reconnaissance survey.

3.18.4.4 Intensive Survey of High-Probability Areas for the Preferred Alternative

A TxDOT archeologist evaluated the potential for the proposed undertaking to affect archeological historic properties (36 CFR 800.16(l)) or SALs (13 Texas Administrative Code [TAC] 26.12) in the area of potential effect (APE). The APE comprises the existing ROW within the project limits (and any areas of new ROW or easements). The APE extends to the maximum depth of impact below the modern ground surface. Current schematic designs for the project estimate that depth to extend 25–50 feet below current ground surface. Section 106 review and consultation proceeded in accordance with the First Amended Programmatic Agreement among the FHWA, TxDOT, the Texas State Historic Preservation Officer (SHPO), and ACHP regarding the Implementation of Transportation Undertakings, as well as the Memorandum of

Understanding between the THC and TxDOT. The following documentation presents TxDOT's findings and explains the basis for those findings.

An intensive survey of the APE was performed under Texas Antiquities Permit No. 2553. On the basis of these investigations, four recorded sites were revisited, 41FB272, 41FB127, 41FB128, and 41FB134; all were historic-age sites, though 41FB272 also had a possible prehistoric component. Based on the revisits, it was determined that all of the sites were extensively disturbed by modern urban development and were not considered NRHP eligible under the criteria of 36 CFR 60.4. No further research was recommended at these site locations.

The intensive survey of previously identified HPAs resulted in the recording of three historic-age sites:

- 41BO212 – a historic-age site of unidentified use or function. Cultural materials observed on the surface included red brick fragments, iron fragments, and clear glass fragments. Four shovel-tests and a single backhoe trench were excavated. The shovel-tests yielded a metal hinge, two clear glass fragments, and an unidentified animal bone. The trench yielded clear glass fragments (some from a modern bottle), decomposed unidentifiable nails, fence staples, a thick brown ceramic sherd, white porcelain sherds, and faunal remains. All excavated cultural materials were encountered at 10–20 centimeters below the surface. According to an informant from the Darrington Prison unit, local accounts suggest that the location of this site may be associated with an African-American antebellum and postbellum occupation, possibly former slave quarters.
- 41BO213 – a known historic-age dump. According to an informant from the Darrington Prison unit, this site has been in use as a dump since the existence of the prison. The close proximity of this dump to 41BO203 (the Mary Bingham residence – within the Francis Bingham plantation) and 41BO204 (a structure possibly associated with the Bingham house), may indicate a possible association with the Bingham Plantation. Numerous cultural materials were observed during the pedestrian survey on the ground surface including porcelain toilet sherds, brick fragments, plastic, metal fragments, glass, rubber, and clothing pieces. A single trench was excavated within the boundaries of 41BO213; no cultural materials were observed.
- 41BO218 – the reported location of a "brick-lined well" and structure. An informant from the Darrington Prison unit reported that the site is possibly associated with a watering station for the Houston, Tap, and Brazoria Railroad, constructed in 1854 and continuing in use until about the Great Depression under the Houston and Great Northern line, the Gulf, Colorado, and Santa Fe line, and the Atchison, Topeka, and Santa Fe line. The informant reported that the prison had excavated the well to a depth of 2.4 meters below the surface and capped the remnant of the well. Six shovel tests were excavated, no cultural materials were encountered, nor were any observed on the surface. No evidence of a structure was observed.

The NRHP eligibility of these three sites has not been determined. Eligibility testing at the three sites was recommended to determine significance if these sites cannot be avoided.

Based on archival research, two additional HPAs were identified:

- An area of the Preferred Alternative adjacent to the Mary Bingham residence, which is recorded as 41BO203 and 41BO204, both of which are outside of the preferred alignment (east of Oyster Creek and adjacent to Willow Lake); this area is also the same HPA where 41BO213 was encountered.
- The area within the Preferred Alternative between 41BO212 and the Brazos River and 100 meters to the east of 41BO212.

It was recommended that these areas should be systematically surveyed by metal detectors and auger testing to identify any cultural materials that may be associated with Old Three Hundred and plantation-era sites and may yield information regarding historic plantation settlement patterns. It was further recommended that if 41BO212, 41BO213, and 41BO218 cannot be avoided, by adjustments in final design (or depth of impact in the case of 41BO218), each of these sites should be tested for NRHP eligibility. TxDOT suggests that the sites be formally tested to determine eligibility in order to determine whether redesign is necessary.

TxDOT completed its review on September 18, 2006 (Bettis, 2006; Appendix I), and the Texas SHPO concurred with all findings and recommendations on October 10, 2006. As of August 31, 2002, TxDOT had received no objection to the project from federally recognized Native American tribes with a demonstrated historic interest in the project area, although all asked to be kept apprised of progress.

3.18.5 Historic Resources

The information reported in this section generally describes nonarcheological historic resources, or buildings, structures, objects, sites and districts that are 50 years of age or older, within the study area and how they relate to the major periods of historic development discussed above in the Cultural Chronology. A more detailed discussion of these resources as they occur in relation to the alternatives considered for this project is presented in Section 4.17.

3.18.5.1 Nonarcheological Historic Properties

A search of official cultural resource agency records and site listings at the outset of the original nonarcheological historic resource investigations indicated that no historic properties (NRHP-listed, NRHP-eligible, Recorded Texas Historic Landmarks, nonarcheological SALs, or Official Texas Historical Markers) had been recorded in the study area. However, it was anticipated that other historic resources in the study area might be eligible for NRHP listing and could be subject to impacts as a result of this project. Following completion of the nonarcheological historic resource surveys, the George Ranch Historical Park was determined eligible for the NRHP listing and one building within the park, the Pickens House, was designated as an Recorded Texas Historic Landmark.

3.18.5.2 Historic Resources Survey Results

To identify historic-age resources in the study area, research was conducted of historical maps of Fort Bend and Brazoria counties, TxDOT's Historic Bridges Inventory, local historical literature, and knowledgeable informants before a historic resources survey was conducted. Review of the 1930s and 1950s State Highway Department maps for the study area revealed that the study area was still largely undeveloped agricultural land into the mid-twentieth century, with a typical pattern of house sites located along the edges of the county and state roadways. It was also apparent from historical maps that concentrations of historic buildings could occur, particularly in the vicinity of older railroad towns, such as Bonney, Rosharon, and Crabb. Other historic building sites and cemeteries were also anticipated across the study area, but in more remote locations, such as the Big Creek area in the south-central portion of the study area. While suburban development in the study area is having an increasingly destructive impact on the older buildings and occupation sites, particularly in the northern part of the study area, land use in the study area is still dominated by farms and ranches.

In general, the array of residential, commercial, agricultural, industrial and ecclesiastical building types observed in the study area represent patterns of rural agricultural and community development that were typical of Texas and the Brazos Valley in the late nineteenth to mid-twentieth century period. Individual family dwellings were the most common building type, with virtually all examples representing common "national folk" house styles that spread across the United States after the arrival of railroads. These styles include late nineteenth century "Victorian" farmhouses, early twentieth century Bungalows, and mid-twentieth century Ranch houses. One factor that contributed to the nationwide distribution of these house types was the widespread availability of mass-produced building materials after the arrival of the railroad (McAlester and McAlester, 1984).

Generally, surviving examples of the more recent building types and styles are more abundant than examples of the older types and styles. Notably, very little architectural evidence remains in the study area to represent the earlier period of immigration, settlement, and agricultural development in the early to mid-nineteenth century. For example, the only hand-crafted Anglo-American log cabins observed by the research team are located in the George Ranch Historical Park, and evidence of mid-nineteenth-century plantation houses has been limited largely to archeological foundation elements. Instead of log cabins and grand plantation homes that characterized the area in the early to mid-nineteenth century period, it is the individual farmstead site of the late nineteenth to early twentieth century period that has survived and characterizes historic architectural development patterns of the study area today.

A particularly intact group of tenant farmhouses associated with the George Ranch was identified along FM 762, outside of the George Ranch Historical Park boundaries. These houses retain their architectural integrity both as individual building sites and as a group of related tenant farmsteads situated within intact agricultural lands still owned and cultivated by the George Ranch. Coordination of these architectural resource sites with Texas SHPO resulted in their being determined eligible for NRHP listing (Sadowski, 2000; Appendix I). Elsewhere in the study area, tenant farmsteads still exist either as individual dwellings or as intact groups of buildings, often within a relatively small tract of agricultural land. Most, however,

have lost much of their original land and architectural integrity, leaving only an isolated house or barn within a few acres that may or may not be actively used for agricultural production.

Several communities were identified that reflect the study area's civic development patterns, particularly after the arrival of the railroads in the latter nineteenth century. The most recognizable communities include Bonney, Rosharon, and Crabb (originally called Crabb Switch). Bonney and Rosharon each contain substantial numbers of potentially historic buildings that reflect residential, commercial, and agricultural developments typical of small, rural town sites in the late nineteenth to early twentieth century period. Additionally, Bonney and Rosharon each contain concentrations of buildings that may represent African American settlements that occurred frequently in such communities. Otherwise, Crabb has lost many of its historic period buildings but still retains two core commercial elements: the Old Crabb Store and the Crabb Rice-Drying Plant. Both of these resources have been determined eligible for NRHP listing and are located adjacent to the two primary transportation routes through Crabb, FM 2785 and the Atchison, Topeka, and Santa Fe Railway.

Historic maps of the study area indicate that some early agricultural communities also existed in the study area, but were more dispersed and lacked a typical town center. For example, a dispersed group of older buildings was identified along Big Creek in the south-central portion of the study area. Review of historical records and maps does indicate the presence of an early to mid-nineteenth century "Big Creek" community in this general area. However, very few of the buildings in this area appear to date to the nineteenth century, and several of the older building sites appear to have been moved in from other locations. Local informants confirm this interpretation for a church building formerly located in Arcola.

3.19 HAZARDOUS MATERIALS

A GeoSearch™ Report, dated May 4, 2011, was ordered to identify potential hazardous materials sites within the proposed ROW of Representative Alternatives 1-8 and the majority of the Preferred Alternative. Additionally, another GeoSearch™ Report, dated November 9, 2011, was ordered to identify potential hazardous materials sites for the remaining portion of the Preferred Alternative that was not covered in the May 4, 2011, Report. GeoSearch™ is an environmental database company that provides a list of available federal, state, and local databases of known or potential hazardous waste or petroleum product facilities, landfills, and facilities currently under investigation for environmental violations in the surrounding area. A field survey was also conducted in May 2010 for the entire project area and June 2011 for the segments. Some of the database information that is included in the GeoSearch ™ Report is as follows:

Federal

- Aerometric Information Retrieval System/Air Facility Subsystem
- Biennial Reporting System
- Clandestine Drug Laboratory Locations
- EPA Docket Data

- Federal Engineering Institutional Control Sites
- Emergency Response Notification System (ERNS)
- Facility Registry System (FRS)
- Hazardous Materials Incident Reporting System
- Integrated Compliance Information System (formerly Dockets)
- Integrated Compliance Information System National Pollutant Discharge Elimination System
- Material Licensing Tracking System
- National Pollutant Discharge Elimination System
- PCB Activity Database System
- Permit Compliance System
- Comprehensive Environmental Response, Compensation, and Liability Information System Liens
- Section Seven Tracking System
- Toxics Release Inventory
- Toxic Substance Control Act Inventory
- No Longer Regulated Resource Conservation and Recovery Act (RCRA) Generator Facilities
- Resource Conservation & Recovery Act – Generator Facilities
- Brownfields Management System
- Comprehensive Environmental Response, Compensation and Liability Information System
- Land Use Control Information System
- No Further Remedial Action Planned Sites
- No Longer Regulated RCRA non-CORRACTS Treatment, Storage or Disposal Facilities
- Open Dump Inventory
- Resource Conservation & Recovery Act – Treatment, Storage & Disposal Facilities
- Delisted National Priorities List
- Department of Defense Sites
- Formerly Used Defense Sites
- No Longer Regulated RCRA Corrective Action Facilities

- National Priorities List
- Proposed National Priorities List
- Resource Conservation & Recovery Act – Corrective Action Facilities
- Record of Decision System

State

- Groundwater Contamination Cases
- Historic Groundwater Contamination Cases
- TCEQ Liens
- Municipal Setting Designations
- Notice of Violations (NOVs)
- State Institutional/Engineering Control Sites
- Spills Listing
- Dry Cleaner Registration Database (DCR)
- Industrial and Hazardous Waste Sites
- Permitted Industrial Hazardous Waste Sites
- Petroleum Storage Tanks (PST)
- Affected Property Assessment Reports (APAR)
- Brownfields Site Assessments
- Closed and Abandoned Landfill Inventory (CALF)
- Innocent Owner/Operator Database
- Leaking Petroleum Storage Tanks (LPST)
- Municipal Solid Waste Landfill Sites (MSWLF)
- Railroad Commission Voluntary Cleanup Program and Brownfield Sites
- Radioactive Waste Sites
- Tier II Chemical Reporting Program Facilities (TIERII)
- Voluntary Cleanup Program
- Recycling Facilities

- State Superfund
- Texas Railroad Commission data on oil wells
- Underground Storage Tanks on Tribal Lands
- Leaking Underground Storage Tanks on Tribal Lands
- Open Dump Inventory on Tribal Lands
- Indian Reservations

(Note: acronyms listed above are not listed in the acronyms list for the document.)

3.19.1 Hazardous Material Sites

A total of 37 potentially hazardous material sites were listed in the GeoSearch™ Reports (Exhibit 15 and Table 3-23). It should be noted that orphan or unmappable sites listed in the database review were reviewed and included, if applicable.

Of the 37 hazardous materials sites listed, 12 sites contain PSTs. Three LPSTs were located within the study area at A Plus Cleaners, KMS Kwik Stop Food Mart, and Gonyos Service Station. Three landfills were identified within the study area, one listed as MSWLF and two listed on CALF. One IHW were located within the study area. Six facilities are listed in the Facility Registry System (FRS). Eight dry-cleaning facilities were listed on the DCR. Sixteen facilities are classified under TIERII. Five NOVs have been given to five facilities. One APAR has been filed for the TDCJ in Rosharon. One facility contains ERNS.

3.19.2 Oil/Gas Well Sites

A search of publicly available records for oil/gas well sites was conducted for the study area. The following Railroad Commission of Texas (RRC) records were reviewed for this study.

RRC Oil and Gas Division county base maps, field maps, Geographic Information System (GIS) maps, and Well-Bore Database – The RRC issues permits and approval for drilling of oil and/or gas wells within the State of Texas. All permitted wells are plotted on various RRC maps and placed in a Well-Bore Database maintained by the RRC.

Approximately 825 oil and/or gas well sites were identified within the study area. The majority of these wells are located in the Thompsons Oil & Gas Field, which is located in the northeastern portion of the study area. The remaining wells are sparsely scattered throughout the study area. The RRC records indicate that approximately 156 wells are currently producing oil and/or gas within the study area. Sixty-five well sites are classified as sidetrack well surface locations and should be considered as active. One well is currently reported as temporarily shut-in, and 15 wells are used as injection wells. A total of 256 of the well sites within the study area are classified as dry holes, and 223 are formerly production wells

TABLE 3-23
HAZARDOUS MATERIAL SITES LISTED IN GEOSEARCH™ REPORT

Site Name	Map ID[1]	Address	Facility Type	Potential for Impacts
Handi Stop 33	1	1750 Crabb River Road	PST, FRSTX (2), NOV	No
Z Bar	2	1612 Crabb River Road	NOV	Low
Greatwood	3	1720 Crabb River Rd.	FRSTX, TIERII	No
Pilgrim Cleaners 162	4	1270 Crabb River Road	FRSTX, DCR	No
Fort Bend County MUD 116	5	1003 Crabb River Road	TIERII, ERNSTX, FRSTX, NOV	Low
Timewise Foodstore 3301	6	1274 Crabb River Road	PST, FRSTX, NOV	Low
Crystal Cleaners	7	1510 Crabb River Road	NOV, FRSTX (2), DCR	No
Buc-ee's 31	8	1243 Crabb River Road	PST	No
My Favorite Cleaners	9	17436 West Grand Parkway South	DCR	No
A Plus Cleaners	10	20335 Southwest Freeway	LPST, PST, DCR	Low
County Cleaners	11	103 Crabb River Road, Suite B	PST, DCR	No
Memorial Hermann Sugar Land Hospital	12	17500 West Grand Parkway South	TIERII (2)	No
KMS Kwik Stop Food Mart	13	909 Crabb River Road	PST, LPST	Low
Booth Compressor Station	14	7431 FM 762	TIERII	No
Plus Cleaners	15	20107 Southwest Freeway	DCR	No
Fort Bend County Mud 116 W1	16	1643 Brazos Gate Drive	TIERII	No
Road And Bridge Crabb	17	201 Payne Lane	PST (2)	No
Crabb River Shell	18	110 Crabb River Road	PST	No
HEB 563	19	19988 Southwest Freeway	PST	No
Rosenberg	20	235 Benton Road	PST	No
Fort Bend County MUD 106 W1	21	6660 Greatwood Parkway	TIERII	No
Archie Lee West Estate	22	5.0 miles Southeast of Richmond on Left of Highway 762	CALF	Low
Crabb River Cleaners	23	738 Crabb River Road	IHW, DCR	Low
Plant 3	24	5200 Ranson Road	PST (2), TIERII (2)	No
Pilgrim Cleaners 179	25	6560 Greatwood Parkway, Suite 400	DCR	No
Lowen Garcia	26	0.25 mile East of Crabb on Highway 762	CALF	Low
River Road Animal Clinic Landfill	27	401 Crabb River Road	MSWLF	Low
Fort Bend County LID 10	28	5955 East Riverpark	TIERII	No
Lamar CISD S1	29	5111 FM 762	TIERII (2)	No
Gonyos Service Station	30	6107 Thompson	LPST	Low
Lamar CISD W1	31	5112 FM 762	TIERII	No
Richmond Plant #2018	32	4815 Ranson Road	TIERII	No
Fort Bend County MUD 116 S2	33	5323 ½ Carta Valley Lane	TIERII	No
Schlumberger Reservoir Completions	34	14910 Airline Road	TIERII	No
Gulf Coast Concrete and Shell Inc.	35	4713 Ransom Road	TIERII	No
Fort Bend County MUD 1 L2	36	2526 Sparrow Branch Court	TIERII	No
Texas Dept of Criminal Justice Rosharon	37	59 Darrington Road	TIERII, APAR	Low

that are now reported to be plugged and abandoned. The remaining well sites are classified as either permitted (41) or cancelled (68) drilling locations. Exhibit 15 depicts the location of the Thompsons Oil & Gas Field.

3.20 VISUAL AND AESTHETIC QUALITIES

Aesthetic quality refers to an individual's subjective perception of natural beauty in a landscape. It can be determined by the presence of designated scenic areas, overlooks along trails or roadways, or by a positive endorsement of a particular view by the public. Aside from these general descriptors, a number of factors may be taken into account when considering the aesthetic quality of a certain feature or landscape. Among these are the following:

- Uniqueness of the landscape in relation to the region as a whole
- Whether the scenic area is a foreground, middle-ground or background view
- Focus of the view
- Scale of elements in the scene
- Number of potential viewers
- Duration of the view
- Amount of previous modifications or disturbance to the landscape

Based on these criteria, the corridor is considered to exhibit a low to medium degree of aesthetic quality, with few unique or necessarily spectacular views. Although a majority of the land in the corridor is in agricultural use, many areas, primarily within the northern third, are undergoing rapid conversion to urban uses, and still other areas are dominated by large, wooded expanses. As a result of this conversion, the landscape is characterized by varying degrees of human influence.

The region is characterized by flat terrain, vegetated with several large tracts of mature hardwoods, grasslands, and cropland. Numerous creeks and streams, wetlands, man-made stock ponds and irrigation canals, and the Brazos River course through the area. Most of the existing vegetation is low and consists of cultivated crops during the growing season. Inundated agricultural fields within the area can serve as migratory bird viewing sites. In addition, Brazos Bend State Park and George Ranch Historical Park are two publicly accessible natural and historic attractions within the study area.

TxDOT has mapped 10 separate "Travel Trails" throughout Texas to provide travel routes that highlight natural, cultural, and scenic attractions within different areas of the state. These routes are described in pamphlets distributed by TxDOT offices and tourist information centers, and marked by special signs along designated highways. The "Texas Independence Trail" encompasses 40 distinct sites throughout southeastern Texas that mark locations and events pivotal to the fight for Texas freedom. The section of US 59 that delimits the northernmost end of the study area is part of this scenic highway loop. This portion of the drive does not indicate any designated scenic views or landmarks (TxDOT, n.d.).