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4.0 AFFECTED ENVIRONMENT

This chapter describes the human, physical, biological, and cultural environment that may be affected by the operation of the Longhorn Pipeline System (System), the remaining construction of the El Paso area lateral pipelines (the proposed Fort Bliss Route and the Montana Avenue Alternative), and the new pump stations. The existing environment associated with the Austin Re-route Alternative also is described as well as the existing environment associated with the Aquifer Avoidance/Minimization Route summarized from the 1987 Supplemental EIS for the proposed All-American Pipeline.

4.1 HUMAN RESOURCES AND LAND USES

Human resources were evaluated to identify distribution of population, vulnerable receptors (e.g., schools, day care centers, parks, health care facilities, correctional facilities, and overnight lodging facilities), existing and planned land uses, and transportation features along the System. The human resource analysis identifies segments of the pipeline that were determined to be environmentally vulnerable areas due to population density and/or proximity to vulnerable land uses and receptors.

4.1.1 Regional Setting

Human resources and land uses along the entirety of the existing pipeline (including the Odessa Lateral) are discussed in a regional perspective in the following text. The context of the discussion includes:

- Potentially affected communities;
- Regional land uses;
- Population density;
- Regional transportation network; and
- Regional parks and natural areas.

Detailed analyses of the Houston and Austin metropolitan areas, the El Paso Laterals and the Austin Re-route Alternative are provided in Sections 4.1.2, 4.1.3, and 4.1.4; respectively. There is not a detailed analysis of the Aquifer Avoidance/Minimization Route Alternative, although it is noted that a route could be constructed to largely avoid any current population vulnerable areas.

4.1.1.1 Potentially Affected Communities

The existing Longhorn pipeline crosses through 22 counties as shown in Figure 3-1.

Four incorporated areas are crossed:

- Houston (Harris County);
- Galena Park (Harris County);
- Jacinto City (Harris County); and
- Austin (Travis County).

The pipeline is adjacent to several rural and unincorporated neighborhoods and subdivisions, including:

- Indian Lake Estates (Bastrop County);
- Lake Thunderbird Estates (Bastrop County);
- Oak River Estates (Bastrop County);
- Stony Point (Bastrop County);
- Stoney Ridge (Travis County);
- Lookout Point (Travis County); and
- Cedar Valley (Travis County).

Large municipalities in the vicinity of the pipeline include:

- Johnson City (4 miles south of the pipeline);
- Junction (12 miles south of the pipeline);
- Eldorado (2 miles north of the pipeline);
- Big Lake (2 miles south of the pipeline);
- Crane (3 miles south of the pipeline); and
- El Paso (the El Paso Terminal is located approximately 3 miles east of the El Paso municipal boundary).

Longhorn pipeline crosses through, and is in proximity to, numerous unincorporated communities between Houston and Austin, including:

- Pleasant Grove (approximately 1.5 miles north of the pipeline);
- Ueckert (1.5 miles south of the pipeline);
- Travis and Scranton Grove (0.5 miles north of the pipeline in Austin County);
- Shelby (crossed by pipeline in Austin County);
- Bleiblerville (crossed by pipeline in Austin County);
- Welcome (crossed by pipeline in Austin County);
- Walhalla (crossed by pipeline in Fayette County);
- Nechanitz and Warda (1.5 miles north of the pipeline in Fayette County);
- St. Martin (0.5 miles north of the pipeline in Fayette County);
- Shiloh (0.5 miles south of the pipeline in Bastrop County);

- Wrights (1.0 miles north of the pipeline Bastrop County);
- Pilot Knob (crossed by pipeline in eastern Travis County);
- Willow City (2.0 miles south of the pipeline in Gillespie County); and
- Barstow (2.0 miles south of the pipeline in Ward County).

4.1.1.2 Regional Land Uses

Land uses along the existing Longhorn pipeline from Houston to El Paso and the Crane-to-Odessa Lateral are classified as:

- Urban residential;
- Urban industrial/commercial;
- Urban undeveloped;
- Rural residential;
- Mineral extraction;
- Agricultural/rangeland; and
- Special use (e.g., vulnerable receptors such as parks, schools, hospitals).

Urban residential lands are confined to the Houston and Austin metropolitan areas. Although most residential land use areas are comprised of single-family dwellings, numerous multi-family units are present in both cities.

Urban industrial/commercial land uses along the pipeline are typically associated with development along major urban arterials.

Urban undeveloped areas are characterized as undeveloped (vacant) land within metropolitan areas.

Rural residential land use typically consists of subdivisions with relatively low housing density (single-family dwellings that are often located on parcels that are greater than 2 acres), in unincorporated areas near major cities.

Mineral extraction land uses include oil and gas fields.

The agricultural/rangeland land use classification encompasses most areas that have not been developed or are not within the vicinity of metropolitan areas. Many such areas are jointly used for rangeland or crop land and for mineral extraction purposes, with livestock grazing and/or crop production taking place within oil fields.

Special use areas are vulnerable receptors such as parks, schools, health care facilities, and correctional facilities.

As shown in the table below, urban residential, industrial/commercial, and urban undeveloped land uses along the pipeline account for approximately 6 percent of the 695-mile-long pipeline from Houston to El Paso, and rural residential land uses comprise approximately 2 percent of land uses along the pipeline.

Agricultural/rangelands constitute more than 90 percent of the Houston-to-El Paso pipeline. Arable lands crossed by the System are most concentrated from Harris County to Schleicher County, as shown on Figure 4-1. Based on an analysis of Natural Resources Conservation Service data (various publications and dates), more than 56 linear miles of prime farmland are crossed by the existing pipeline. Distances crossed within the area between Houston and Austin total approximately 44 linear miles; approximately 12 miles of prime farmland are crossed between Austin and central Schleicher County (Note: data were not available for Fayette or Mason counties). Crop production throughout the alignment includes wheat, alfalfa, oats, grain sorghum, and corn.

Land uses along the Odessa Lateral are predominantly agricultural/rangeland, although much of the area is also used for mineral (oil and gas) extraction. A 3,000-ft segment of the pipeline parallels the boundary of Pleasant Farms Subdivision in Ector County.

Land Uses Crossed by Longhorn Pipeline

	Houston - El Paso		Odessa Lateral	
Land Use Classifications	**Miles**	**Percent**	**Miles**	**Percent**
Urban Residential	42	6	0	0
Urban Industrial/Commercial	2	<1	0	0
Urban Undeveloped	2	<1	0	0
Rural Residential	12	2	0	0
Agricultural/Rangeland*	634	91	28	100
Special Use	3	<1	0	0
Total	**695**	**100**	**28**	**100**

*Including areas that are jointly used for mineral (oil and gas) extraction.

Mineral extraction (oil and gas production) is common in agricultural/rangeland land use areas in the Permian Basin (including the vicinity of Crane and Odessa) and in scattered locations elsewhere. Oil fields located along the pipeline between Houston and El Paso include Racoon (*sic*) Bend in Austin County; Price, Big Lake, and Benedum oil fields in Reagan County; Amacker-Tippett and Jack Herbert oil fields in Upton County; McElroy, Block 31, Lea, Sand Hills South, and Running W oil fields in Crane County; and South Ward and Ward Estes North oil fields in Ward County. Oil fields along the Odessa Lateral include Dune, Concho Bluff, Double H, University-Waddell, and South Cowden.

4.1.1.3 Regional Population Density Analysis

4.1.1.3.1 Housing

There are no defined corridor width requirements for liquid pipelines relative to potential damages. US Department of Transportation (DOT) applies the concept of class location based on building counts within a distance of 220 yards (660 feet [ft]) on either side of natural gas pipelines. This distance was considered too narrow for the concerns of this study, and a wider width was selected. A distance of 1,250 ft to each side of the pipeline (2,500 ft total) was chosen as representative of a corridor of potential impacts from the pipeline. The basis for this distance is described in Section 6.2.4 of this EA.

Next, areas along the pipeline within this corridor were classified by a measure of population density. Three zones were defined according to the number of occupied residential units within the 2,500-ft-wide corridor (1,250 ft on both sides of the pipeline). Low density was defined as 0 to 20 residential units per mile; moderate density from 21 to 1,000 residential units; and high density, greater than 1,000 residential units per mile. Since the wider corridor was selected for this Environmental Assessment (EA), the EA criteria are approximately consistent with the 49 CFR Part 192 criteria but provide a simpler classification scheme.

Of the 695 miles of pipeline between Houston and El Paso, there are 5.3 miles (less than 1 percent of the total) that are categorized as high density. Of these 5.3 miles, 5.2 miles are in Harris County and 0.1 mile is in Travis County. Results of the analysis also indicate that an additional 12.5 percent of the Houston-to-El Paso alignment has between 21 and 1,000 units per linear mile within 1,250 ft of the pipeline (moderate density). The remaining 87 percent of the alignment has less than 20 dwelling units per linear mile within 1,250 ft of the pipeline (low density). A summary of this analysis is provided on Table 4-1, which includes a listing of major subdivisions and neighborhoods that are crossed by, or in proximity, to the pipeline. (The Odessa Lateral has only five dwellings along its route.)

Aerial photography and ground-based surveys were used to determine the number of housing units within the 2,500-ft-wide corridor and to provide the basis for estimating population within 1,250 ft from the pipeline. A description of the dwelling count methodology and detailed results of the dwelling unit and population estimates analyses are provided in Appendix 4A.

The greatest concentration of housing and population is in the Houston area where approximately 15,400 dwelling units are within 1,250 ft of the pipeline centerline. The second most concentrated area of housing and population is in the Austin area where approximately 3,600 dwelling units are within 1,250 ft of the pipeline. A listing of multi-family facilities (apartments) within the Houston and Austin metropolitan areas is provided in Appendix 4A.

4.1.1.3.2 Population

The total population of the 22 counties crossed by Longhorn pipeline was an estimated five million during 1998, as indicated on Table 4-2. Population estimates along the existing Houston-to-El Paso Longhorn pipeline were based on the inventory of dwelling units and average population numbers per household by county as determined from 1990 Bureau of Census data. Results of the analysis indicate that approximately 52,700 persons are within 1,250 ft of the pipeline. Of these 52,700 persons, approximately 41,950 (80 percent) reside within 1,250 ft of the pipeline between milepost (MP) 1 and MP 37 in Harris County, and 8,930 (17 percent) reside within 1,250 ft of the pipeline between MP 160 and MP 180 in the Austin area. Most of the remaining 1,800 (3 percent) population along the pipeline is between Houston and Austin. Approximately 500 persons reside within 1,250 ft of the pipeline between Hays County and the El Paso Terminal.

Vulnerable Population Areas

Additional analyses of densities along 0.10-mile segments of the pipeline were performed to provide a basis for identifying vulnerable population areas. For example, approximately 17.9 percent of the total housing units within the study corridor are found along 1.2 miles of the pipeline, primarily in the Houston area. An additional 19.2 percent of the total housing is found along an additional 3.2 miles of the pipeline. In combination, 37.1 percent of all housing within the study corridor lie along a total of 4.3 miles of the pipeline.

Dwelling Density Analysis

Dwelling Thresholds Analysis	Number of Segments	Percent
100+ per 0.10-mile segment [a]	44 [a]	0.6 [a]
20+ per 1-mile segment	58	8.3
1 - 19 per 1-mile segment	90	12.9
None per 1-mile segment	547	78.7

[a] 100+ per 0.1-mile segment represents a subset of the 20+ per 1-mile segment total.

Of the 44 0.1-mile segments with more than 100 dwelling units, 43 are in Houston; the other segment is in Austin. Twenty-eight of the 43 Houston segments are in east Houston, and 15 segments are in west Houston. Those areas with the greatest concentration of dwelling units in Houston are largely comprised of multi-family facilities. The single segment in Austin includes a 190-unit multi-family facility.

Figures 4-2a-h show population densities within the Houston area; population densities in the Austin area are shown on Figures 4-3a through d.

Results of the June 1999 field survey of the Crane-to-Odessa Lateral indicate that five dwelling units are within 1,250 ft of the pipeline in the Pleasant Farms Subdivision. Based on Bureau of Census average numbers of persons per household (2.8), 14 individuals reside within 1,250 ft of the pipeline along the Odessa Lateral.

Based on Texas State Data Center projections, the counties expected to experience the greatest population increases from 1998 to 2020 and 2020 to 2030 are Bastrop, Hays, and Blanco.

4.1.1.4 Transportation Networks

The existing Houston-to-El Paso pipeline crosses approximately 20 federal highways, 15 state highways, and numerous state-designated Farm-to-Market (FM) and Ranch Roads. The pipeline also crosses numerous city streets (primarily in the Houston and Austin metropolitan areas), county roads, and 15 railroads. Highway and railroad crossings are listed by county in Appendix 4B.

4.1.1.5 Parks and Natural Areas

The existing Longhorn pipeline crosses Buescher and Pedernales Falls state parks and lies within 200 ft of the southern boundary of McKinney Falls State Park. Bastrop and Enchanted Rock state parks are each approximately 3 miles north of the pipeline; Fort McKavett State Park and Hueco Tanks State Park are 11 and 12 miles north of the pipeline, respectively, as shown on Figure 4-4.

Buescher State Park is in Bastrop County, between pipeline MP 127.5 and MP 128.8. The 1,000-acre park is within the Lost Pines area of central Texas. Amenities include camping, group facilities, picnicking and fishing facilities, and bicycling and hiking trails. Texas Parks and Wildlife Department (TPWD) reported that the number of annual visitors to the facility from 1993 through 1998 averaged 356,768 (TPWD, 1999).

Pedernales Falls State Park is in Blanco County and is approximately 9 miles east of Johnson City. The 5,200-acre park is located between MP 194.5 and 197.0. Camping and group facilities, picnic, trails, swimming, and fishing facilities are available. The average number of annual visitors to the park from 1993 through 1998 totaled 242,656.

McKinney Falls State Park is in eastern Travis County. The boundary of the 744-acre park is within 200 ft from MP 162.9, and approximately 95 acres are within 3,000 ft of the pipeline. Camping and group facilities, picnic, swimming, trails, and an interpretive center are provided. TPWD records indicate that the number of annual visitors during 1993 through 1998 averaged 322,334.

Enchanted Rock, McKinney Falls, and Pedernales Falls are all downstream of pipeline crossings of streams or rivers that run through the park. Other parks, natural areas, and surface waters for water recreation and fishing, or other areas along the pipeline that could be affected by an accidental release of product include Texas Highland Lakes, Harmonie Park in the community of Shelby (Austin County, MP 93.8), Colo Vista Country Club (Bastrop County, MP 133.9 to 134.3), West Cave Preserve and Hamilton Pool Preserve along the Pedernales River in western Travis County, and Stephen F. Austin State Historical Park along the Brazos River in Austin County.

Approximately 1.5 miles of the City of Austin Watershed Protection land purchases in western Travis County are crossed by Longhorn pipeline (see Section 4.2.2.2.5).

Vulnerable receptors are tabulated by MP in Table 4-3.

4.1.2 Other Receptors in the Houston and Austin Areas

4.1.2.1 Houston Area

The Longhorn pipeline originates in an industrial area of the east Houston metropolitan area and extends to the north through the Galena Park Station located in Houston, Texas, portions of the City of Houston, and an unincorporated area of Harris County. Although residential land uses dominate much of the area adjacent to the alignment, industrial/commercial use areas are concentrated in the Galena Park Station industrial area and along major arterials such as Market Street, Wallisville Road, Interstate Highway 10 (I-10), and US 90. Subdivisions and neighborhoods crossed by the pipeline within the eastern Houston area include Holiday Forest, Songwood, Wood Bayou, Wallisville Gardens, Ralston Acres, Houmont Park, and Green River. Urban undeveloped land is scattered as small parcels throughout the area. Land uses along the east Houston portion of the pipeline corridor are shown on Figure 4-2a and Figure 4-2b.

Neighborhoods and Subdivisions

The pipeline turns toward the west at Green River Road and crosses through urban residential areas and urban undeveloped land to the northwestern city limits, as shown on Figure 4-2c and Figure 4-2d. Neighborhoods and subdivisions along the alignment include Parkwood East, Lake Forest Estates, Glenwood Forest, Kentshire Place, Park North, Scenic Woods, Fontaine Place, Sherwood Place, Oakwilde, Melrose Place, Willow Run, Heather Glen, West Mount Houston, Inwood North, Inwood North Estates, Rolling Fork, Arbor Vineyards, Willowbridge, Winchester Country, Steeplechase, Steeplechase Park, Crossroads, Northmead Village, and Aberdeen Trails. Rural residential land use areas begin approximately 2 miles west of US 290 and extend as relatively isolated subdivisions and population centers from the Houston metropolitan area to central Waller County.

Houston Planning Department records were reviewed to identify planned subdivisions that may be constructed along the existing Longhorn pipeline within the city limits and Houston's extraterritorial jurisdiction. Although a comprehensive listing of planned subdivisions was not available, the records that were reviewed indicated that large tracts west of US 290 to the vicinity of Barker Cypress Road are likely to be developed for residential use. Riata Ranch Subdivision would be located near the intersection of Huffmeister Road and Tuckerton Road; Cypress Creek Ranch, Aberdeen, and other subdivisions would be along Tuckerton Road to the west. Areas that have been identified for new development are shown on Figure 4-2h.

Commercial and Industrial

Commercial/industrial land uses are scattered throughout the area with the heaviest concentration along the I-45 corridor, Veterans Memorial Boulevard, as shown on Figure 4-2f, other major arterials, and the Satsuma Terminal, as shown on Figure 4-2h. No semiconductor plants are adjacent to the ROW.

Vulnerable Receptors

Special use areas (or vulnerable receptors) along the pipeline include numerous schools, parks and recreation centers, overnight lodging facilities, and health care facilities. These areas, excluding schools, are shown in Table 4-4.

Special use areas (i.e., vulnerable receptors) within the area include Smith Park and Herman Brown Park, which are located in Galena Park and Houston, respectively. Public and private schools in the area are in residential areas of Galena Park, Jacinto City, Houston, and unincorporated Harris County. There are no rural residential, mineral extraction, or agricultural/rangeland land uses in the area.

The pipeline crosses seven school districts in the Houston metropolitan area. Fifteen schools are within 1,300 ft of the pipeline. Of these, 13 are within 1,250 ft of the pipeline. Also, the pipeline is within 1,250 ft of eight day care facilities. The existing pipeline lies adjacent to Bang Elementary, Cook Junior High, Fonwood Elementary, Langstead Primary, Northwood Middle School property boundaries, First Metropolitan Church Infant Development Center, Northeast Christian School, and Sweetwater Christian School property boundaries. Schools and day care facilities along the Houston portion of the alignment are listed in Table 4-5.

Cypress-Fairbanks (Cy-Fair), Aldine, Klein, North Forest, Galena Park, and Houston Independent School Districts (ISDs) were contacted to determine if new schools are planned to be constructed in the vicinity of the pipeline right-of-way (ROW). Results of the inquiries indicate that none are planned in the vicinity of the Longhorn pipeline.

4.1.2.2 Austin Area

Land uses within the Austin area, including eastern and western Travis County, are shown on Figures 4-3a through d. The uses are predominantly urban residential with the heaviest concentration east of Brodie Lane. Rural residential and agricultural/rangeland land uses within the Austin metropolitan area are limited to those within unincorporated western Bastrop County and eastern and western Travis County.

Neighborhoods and Subdivisions

Subdivisions/neighborhoods crossed by the alignment (east to west) include: Onion Creek Forest, Silverstone, Indian Hills, Meadow Creek, Park Ridge, Buckingham Estates, Parkwood, Tanglewood Forest, Shiloh, Southwest Oaks, Cherry Creek, Sendera Oaks, Sendera Glen, and Village at Western Oaks. Other subdivisions within the metropolitan area include:

Indian Lake, Lake Thunderbird, Oak River Estates, and Stony Point in Bastrop County and East Travis Hills and Stoney Ridge in eastern Travis County. As stipulated in the Settlement Agreement (Settlement), a comprehensive listing of Austin area subdivisions and neighborhoods along the existing pipeline alignment is provided in Appendix 4C.

The Austin Planning-Environmental and Conservation Department was contacted to identify new subdivisions that have been platted for construction. The review was limited to subdivisions with 25 or more platted lots. Data indicate that an additional 180 single-family residences are planned for construction as an extension of the Stoney Ridge Subdivision, southeast of Austin-Bergstrom International Airport. Approximately 200 single-family units have been planned for the area south of Deer Lane and west of Brodie Lane, and approximately 140 units are planned for the area between Davis Lane and West Slaughter Lane. Outside of the city limits, an additional 25 single-family units have been platted in the vicinity of Young Lane, and commercial development is planned for a 69.4-acre parcel at Circle Drive and US 290. Land uses along the corridor through the Austin metropolitan area are shown on Figures 4-3a through d.

Commercial and Industrial

Relatively large areas of undeveloped land are scattered along the alignment, with the greatest concentration west of Brodie Lane. Commercial/industrial land uses are limited to the area between I-35 and South Congress Avenue and at intersections of major arterials along William Cannon Drive, Brodie Lane, and Manchaca Road. Those facilities along and near the I-35 corridor and South Congress Avenue include a variety of retail establishments and small office complexes. The alignment also crosses through a jewelry manufacturing facility between I-35 and South Congress Avenue. Commercial facilities along arterials include a variety of convenience stores, dry cleaners, and gas stations. Although there are numerous semiconductor plants in the Austin area, none are traversed or adjacent to the Longhorn pipeline ROW.

Vulnerable Receptors

The existing Longhorn pipeline crosses four school districts in the Austin area. The Austin ISD includes the south Austin area from the Del Valle ISD to the Hays County line. The district currently operates seven schools that are within 3,000 ft from the Longhorn pipeline. Hays County ISD and Dripping Springs ISD are south and southwest of the City of Austin, primarily in Hays County. The two districts operate a total of seven schools; however, none are in proximity to the existing Longhorn route or the Austin Re-route Alternative. Del Valle ISD encompasses an area southeast of the city, including the area around the new Austin-Bergstrom International Airport. The district currently operates seven elementary schools, a junior high (middle school), a high school, and the Del Valle Opportunity Center for grades 9 through 12.

The district's new high school, Del Valle High School, opened in the fall of 2000 and is more than a mile from the pipeline.

Two day care facilities (Nana's Day Care and Legacy Oaks Christian Schools) are within 1,250 ft from the pipeline and one additional day care facility (Bright Horizons) is within 2,000 ft. Schools and day care facilities that are in the vicinity of the Longhorn pipeline are listed in Table 4-6.

The Austin, Del Valle, Dripping Springs, and Hays County ISDs were contacted to determine if future school sites are in proximity to the existing Longhorn pipeline or the Austin Re-route Alternative. At that time (1999), the Austin ISD indicated that 10 new schools were under construction or planned for construction. A review of names and addresses indicated that one is within 3,000 ft of the existing pipeline alignment—Cowan Elementary. Locations of new Del Valle ISD schools have been previously discussed. Neither Dripping Springs ISD nor Hays County ISD is planning new schools along the pipeline alignment.

Other vulnerable receptors within 1,250 ft of the alignment include a health care facility (The Brown Schools) and the Lone Star Recreation Vehicle Resort (an overnight facility). Parks, health care, and overnight facilities along the pipeline are listed in Table 4-7.

4.1.3 El Paso Terminal

The Longhorn pipeline crosses several large tracts east of El Paso with named and unnamed roads; however, development within the area has not taken place because of lack of city services and financing. The pipeline terminates at the El Paso Terminal, approximately 3 miles east of the El Paso city limits. The area is sparsely populated with only one residential area within 1 mile; Hacienda del Norte Subdivision is approximately 3,000 ft from the pipeline.

Industrial/commercial land uses near the terminal are limited to a drive-in theater and scattered retail establishments along Montana Avenue. There are no areas that would be considered as urban undeveloped, rural residential, mineral extraction, or special use within the vicinity of the pipeline. Although undeveloped land within the area is classified as agricultural/ rangeland, arid conditions and lack of arable land preclude such uses.

4.1.4 Austin Re-route Alternative

A 21-mile-long alternative pipeline route was developed by Longhorn to avoid population concentrations along a 12-mile segment of the existing pipeline within the Austin area. This Austin Re-route Alternative would originate at MP 161, approximately 0.25 miles west of Pilot Knob and connect to the existing pipeline west of Austin at MP 173. Refer to Figure 4-5.

The alignment of this alternative extends in a generally southwesterly direction, crossing undeveloped agricultural land, Colton Bluff Springs Road, and Thaxton Road, before turning toward the west near Old Lockhart Highway and the town of Carl. West of Carl, the alignment crosses Marble Creek, Rinard Creek, FM 1327, North Turnersville Road, I-35, the Union Pacific Railroad, and Onion Creek, before turning to the northwest, paralleling the Travis-Hays county line. The segment that parallels the county line crosses Garlic Creek and Little Bear Creek, before turning toward the west and crossing Little Bear Creek for the second time. West of the second crossing of Little Bear Creek, the alignment turns to the west, crossing north of Buda and south of Manchaca. A third crossing of Little Bear Creek is west of Manchaca Road. The alignment turns northerly near Manchaca Road, crosses Bear Creek, and joins the existing pipeline near the Cedar Valley area.

A land use assessment was conducted along this alternative alignment, including review of recently published local maps (Mapsco, 1999), observation from a fixed-wing aircraft, and two site investigations. Results of the assessment indicate land uses along the alignment to be largely composed of rangeland and scattered single-family residences. A relatively large subdivision (identified on the 1999 Mapsco along the Travis-Hays County boundary) does not exist; however, a new subdivision (Creekside Park), under construction in 1999 and located along FM 967, is not shown on local maps.

Information regarding future land uses acquired from Greg White, City Administrator, City of Buda indicates that no new subdivisions, schools, parks, or other facilities are currently planned along the portion of the Austin Re-route through the Buda area. Furthermore, the development permit for the previously identified subdivision (Woods of Bear Creek) along the Travis-Hays county line has been vacated (White, 1999). Population within 1,250 ft of the proposed alternative alignment was estimated using aerial photo interpretation. Results indicate that approximately 70 dwelling units are within 1,250 ft of the alignment. Based on average numbers of residents per household within Travis County (2.39), an estimated 170 individuals reside within 1,250 ft from the centerline of the 21-mile-long corridor.

4.1.5 El Paso Laterals

The El Paso Planning Department was contacted to determine if new subdivisions are planned for construction near the El Paso Terminal or along the unconstructed laterals. No new subdivisions have been proposed for the area; however, the city exercises little or no control over subdivision development outside the city limits and land development is often pursued without consultation or approval by the city (Fraser, 1999). The El Paso Laterals would be constructed along an alignment located almost entirely within Fort Bliss (proposed Fort Bliss Alignment) or along Montana Avenue (Montana Avenue Route Alternative). Both alignments would originate at the El Paso Terminal and terminate at an injection point along the Kinder Morgan and Chevron interstate lines approximately 8 miles to the west. Both alignments are shown on Figure 3-1. The Longhorn El Paso lateral pipelines would consist of three 8-inch and one 12-inch pipeline that would be installed in a single trench. One of the 8-inch pipelines would be used to create a return system between the El Paso Terminal and the point of the lateral pipeline connections to Kinder Morgan and Chevron. The return system would be used to displace product from within the lateral pipelines back to the El Paso Terminal.

Land use, dwelling units, and locations of other vulnerable receptors that could be affected by construction or operation of four 8-mile-long lateral pipelines from the El Paso Terminal to the Kinder Morgan and Chevron interstate pipelines were identified using local maps and field investigations. Figure 4-6 shows land uses along both routes. Dwelling units and population estimates within 1,250 ft of the El Paso Laterals are summarized in Table 4-8.

4.1.5.1 Proposed Fort Bliss Route

The proposed Fort Bliss Route runs west and then northwest through Fort Bliss, generally parallel to US 375 where it connects with the interstate pipelines approximately 8.3 miles from the El Paso Terminal. The alignment would include construction of three product pipelines and one return pipeline between the terminal and the interstate pipelines and construction of 3.5-mile lines from the terminal to the Ultramar Diamond Shamrock Terminal, west of the Longhorn Terminal. Construction would be through undeveloped desert on Fort Bliss property.

The proposed Fort Bliss Route would be within 1,250 ft of the Butterfield Square (locally known as Pistachos) Colonia, which is located on approximately 640 acres west of the El Paso Terminal (Rodriguez, 1999). Butterfield Square Colonia is reported to have approximately 300 homes and a total of 494 lots. The portion of the Colonia within 1,250 ft of the pipeline contains 70 dwellings with an estimated population of 232. No other vulnerable receptors are within 1,250 ft of the route.

4.1.5.2 Montana Avenue Route Alternative

The Montana Avenue Route Alternative would be located west, southwest from the El Paso Terminal, along Montana Avenue. The alignment would parallel several developed properties and cross several roads and driveways. The alternative is approximately the same length as the proposed Fort Bliss Route and terminates immediately east of El Paso International Airport where it would connect to the interstate pipelines, as shown on Figure 4-6.

The Montana Avenue Route Alternative originates from the southeastern property boundary of El Paso Terminal, which is approximately 8 miles east of El Paso International Airport and approximately 3 miles east of the El Paso city limits. Fort Bliss property borders the north side of the road from the El Paso city limits to Joe Battle Boulevard, a distance of approximately 3.8 miles. The Fort Bliss property line is offset from Montana Avenue, east of Joe Battle Boulevard. Commercial and industrial land uses along the alignment range from a concentration of businesses in the vicinity of the airport to scattered retail, commercial, and industrial facilities to the east. Single- and multi-family residential land uses are predominantly south of Montana Avenue with most offset 120 to 240 ft from the roadway; however, several apartment and mobile home parks are adjacent to the highway ROW. Cielo Vista Church, City Church, Apostle Church, Evergreen Cemetery, and Arvey Park (a recreational vehicle park) are located along the south side of Montana Avenue. County and state correctional facilities are located along the north side of the road, approximately 1 mile east of Joe Battle Boulevard. Land uses, subdivisions, and vulnerable receptors within the area are shown on Figure 4-6.

Other residential areas that are within 1,250 ft from the Montana Avenue Route Alternative include: Del Este Apartments, Del Este II Apartments, Carlsbad Mobile Home Park, Digger Pines Apartments, Las Palmas Subdivision, Palm Desert Subdivision, Hueco Mountain Village, Quail Run Mobile Homes, unnamed mobile home parks east and west of Turf Lane, and single-family residences that are predominantly west of Joe Battle Boulevard. See Figure 4-6.

Single-family dwellings in the area are estimated to total 1,140. Assuming an average population density of 3.31 persons per dwelling unit and assuming that all dwelling units are fully occupied, approximately 3,770 individuals reside within 1,250 ft from the Montana Avenue Route Alternative. This compares with 70 residences and 232 persons estimated to be within 1,250 ft of the proposed Fort Bliss Route. Dwelling units and estimated population numbers within 1,250 ft of the Montana Avenue and the Fort Bliss alternative routes are summarized in Table 4-9.

Four school districts are located in the vicinity of the El Paso Laterals. The area east and south of the Longhorn Terminal is within the Clint ISD, and the Socorro ISD is immediately west of the terminal to Joe Battle Boulevard (US 375). The area north of Montana Avenue, to the vicinity of the El Paso International Airport (including Fort Bliss property), is within the El Paso ISD. The area west of the Socorro ISD and south of Montana Avenue is within the Ysleta ISD.

No schools are within 1,250 ft from the centerline of the Montana Avenue or the Fort Bliss laterals alignments. East Montana Middle School, Montana Vista Elementary School, and Mountain View High School are approximately 1 mile north of the existing Longhorn pipeline and are the closest Clint ISD schools to the project. All three schools serve the Montana Vista area of El Paso County.

There are no Socorro ISD schools within the vicinity of either the existing Longhorn pipeline or alignments that would be crossed by either the proposed Fort Bliss alignment or the Montana Avenue Route Alternative. Cielo Vista Elementary and Edgemere Elementary are approximately 3,000 ft from Montana Avenue and are the closest Ysleta ISD schools to the project, as shown on Figure 4-6.

Milam Elementary is the closest El Paso ISD school to the project. The school is located on Fort Bliss property and more than 2 miles from the Montana Avenue Lateral Alternative. Table 4-9 lists the El Paso area schools.

Ysleta ISD is constructing a new elementary school near the intersection of Montana Avenue and Lee Trevino Drive. The school will serve grades kindergarten through 8 and will have a 600 to 900 student capacity (Escabar, 1999). The location is within 1,250 ft from the alignment.

4.2 PHYSICAL RESOURCES

Physical resources addressed in Section 4.2 include ground water and surface water resources that may be affected by pipeline operations, maintenance, or an accidental release of product. Special consideration has been given to karst formation areas and aquifers along the existing pipeline and the Austin Re-route Alternative. Geologic hazards and air quality issues also are addressed in the section.

4.2.1 Ground Water Resources

4.2.1.1 Description of Ground Water Resources

Parameters/conditions for each aquifer were investigated to assess the relative vulnerability of each aquifer to contamination from a release of refined petroleum product. Vulnerability is defined both in terms of the relative ability of aquifers to transport contaminants to potential receptors (velocity of the ground water flow) and the relative importance of the aquifer as a usable resource (the current type and amount of use). In addition, aquifer characteristics that facilitate or impede remediation following a spill are addressed, where relevant.

This section is organized as follows:

- The major and minor aquifers along the route are described and their relative vulnerability to contamination is estimated (Section 4.2.1.1.1).
- Ground water use along the pipeline route is described (Section 4.2.1.1.2).
- For areas that clearly are environmentally vulnerable, because of a combination of geologic factors and known human consumptive use, a more detailed geologic description is provided (Section 4.2.1.1.3).
- A discussion is provided concerning ground water springflow near the pipeline (Section 4.2.1.1.4).

4.2.1.1.1 Description of Major and Minor Aquifers Along Pipeline Route

The System crosses the outcrops (recharge zones) of several major and minor aquifers as designated by the Texas Water Development Board (TWDB) (Ashworth and Hopkins, 1995) along the 731-mile route from the Galena Park Station located in Houston to the El Paso Terminal (including lateral routes). The potentially vulnerable aquifers were identified from TWDB publications and databases and from registered concerns of the plaintiffs in the Settlement. This listing of potentially vulnerable aquifers is based on known hydrogeologic factors that may make these hydrogeologic units susceptible to contamination from a release of refined petroleum product from the System. These hydrogeologic factors may include (1) depth to water, (2) aquifer media, (3) soil development, (4) transmissivity, (5) whether confined or unconfined, and (6) net recharge. Table 4-10 lists these aquifers from east to west along the pipeline route.

These aquifers, shown on Figure 4-7 and 4-8, are designated as major or minor by TWDB because they may serve as a primary or secondary potable drinking water source for public supply or domestic use. A major aquifer is generally defined as supplying large quantities of water in large areas of the state. Minor aquifers typically supply large quantities of water in small areas or relatively small quantities in large areas. These aquifers, as presently defined, underlie approximately 81 percent of the state (Ashworth and Hopkins, 1995). Lesser quantities of water may be found in the remainder of the state.

Appendix 4D contains descriptions of each major and minor aquifer traversed and provides general information pertaining to location, geology, quality, yield, common use, and specific problems and classifications of the aquifers according to Savoca (Savoca, 1999). The aquifers are organized in the order of their occurrence along the pipeline route from east to west. A summary of the aquifer characteristics is listed in Table 4-10. In addition, the conclusions concerning aquifer vulnerability are briefly summarized below. In the section below, reference is made to a DOT classification of Unusually Sensitive Areas (USAs) (Savoca, 1999). In this classification, Class I aquifers are highly vulnerable, Class II are moderately vulnerable, and Class III aquifers are not vulnerable. Additional qualifiers on the class are "a," unconsolidated formation; "b," soluble or fractured formation; "c," semi-consolidated formation; or "d," covered formation.

Gulf Coast Aquifer System. The Gulf Coast Aquifer forms a wide belt along the Gulf of Mexico from Florida to Mexico. The aquifer consists of complex interbedded clays, silts, sands, and gravels of Cenozoic age, which are hydrologically connected to form a large, leaky artesian aquifer system. The transmissivity of many aquifers in the system is in the range of 100-1,000 square ft per day, with ground water movement measured in terms of a few feet per year. Because of the generally deep and well-developed soils that overlay aquifer outcrops, there are no vulnerable areas with respect to potential ground water contamination underlying the pipeline.

Brazos River Alluvium Aquifer. Water-bearing alluvial sediments occur in floodplain and terrace deposits of the Brazos River of southeast Texas. This aquifer is a Class Ia aquifer under the DOT classification of USAs. Also, the Brazos River Alluvium is rated according to depth to ground water, net recharge, aquifer media, soil media, topography, impact of vadose-zone media, and conductivity of the aquifer (DRASTIC) with an index greater than 110, thereby qualifying it as vulnerable. See Section 4.2.1.2.2 for an explanation of EPA's ground water vulnerability ranking system, called DRASTIC.

Sparta Aquifer. The Sparta Aquifer extends in a narrow band from the Frio River in south Texas northeastward to the Louisiana border in Sabine County. The Sparta Aquifer is a semi-consolidated, high-yield aquifer classified as a Class Ic USA under the DOT classification system. The Sparta Aquifer is therefore considered vulnerable with regard to ground water contamination.

Queen City Aquifer. The Queen City Aquifer extends across Texas from the Frio River in south Texas northeastward into Louisiana. The aquifer is a semi-consolidated, high-yield aquifer classified as a Class Ic USA under the DOT classification system. The Queen City Aquifer is therefore considered vulnerable with regard to ground water contamination.

Carrizo-Wilcox Aquifer. The Wilcox Group and the overlying Carrizo Formation of the Claiborne Group form a hydrologically connected system known as the Carrizo-Wilcox Aquifer. This aquifer extends from the Rio Grande in south Texas northeastward into Arkansas and Louisiana, providing water to all or parts of 60 counties. The Carrizo-Wilcox Aquifer is a semi-consolidated, high-yield aquifer classified as a Class Ic USA under the DOT classification system. The aquifer is therefore considered vulnerable with regard to ground water contamination.

Colorado River Alluvium Aquifer. Water-bearing alluvial sediments occur in floodplain and terrace deposits of the Colorado River of south-central Texas. The Colorado River Alluvium Aquifer is highly transmissive and is readily susceptible to point and non-point source pollution. This aquifer is classified as a Class Ia aquifer under the DOT classification of USAs. Also, the Colorado River Alluvium is rated with a DRASTIC index greater than 110, thereby qualifying it as vulnerable.

Edwards Aquifer (Balcones Fault Zone [BFZ]). The Edwards Aquifer (BFZ) covers approximately 4,350 square miles in parts of 11 counties. The aquifer forms a narrow belt extending from a ground water divide in Kinney County through the San Antonio area northeastward to the Leon River in Bell County. The Edwards Aquifer (BFZ) is classified as a Class Ib aquifer under the DOT classification system as a result of well developed karst topography in the outcrop areas. The outcrop of the Edwards Aquifer (BFZ) is considered vulnerable to highly vulnerable. The highly vulnerable intervals include the outcrops of the Leached and Collapsed Members (undivided) of the Person Formation and the Kirshberg Evaporite Member of the Kainer Formation (Rose, 1972).

Trinity Aquifer. The Trinity Aquifer consists of early-Cretaceous age formations of the Trinity Group where they occur in a band extending through the central part of the state in all or parts of 55 counties, from the Red River in north Texas to the Hill Country of south-central Texas. The Trinity Aquifer areas traversed by the Longhorn pipeline are classified under the DOT system as Class IIa (moderately susceptible). Generally, the Trinity Aquifer system is rated with a DRASTIC index less than 110. Karst areas of the aquifer are relatively uncommon except in the vicinity of the BFZ. Therefore, the Trinity Aquifer area that is traversed by the Longhorn pipeline is not classified as vulnerable for the purposes of this study.

Hickory Aquifer. The Hickory Aquifer occurs in parts of 19 counties in the Llano Uplift region of central Texas. The Hickory Sandstone outcrops are also generally associated with the hydraulically connected Cap Mountain Limestone Member of the Riley Formation. The Cap Mountain Limestone Member is identified as exhibiting characteristics of karst topography, therefore qualifying it and the associated hydraulically connected Hickory outcrops as vulnerable for the purposes of this investigation. In addition, the Texas DRASTIC map identifies these outcrops with an index greater than 110 that also classify the aquifer as vulnerable. The route described as the "Aquifer Avoidance/ Minimization Route" traverses a relatively small interval of confined Hickory Aquifer in the subsurface of northern Concho County. The aquifer is approximately 4,200 ft deep and is not considered at risk or vulnerable in this area. The Hickory Aquifer is classified as a Class IIa aquifer under the DOT system.

Ellenburger-San Saba Aquifer. The Ellenburger-San Saba Aquifer occurs in parts of 15 counties in the Llano Uplift area of central Texas. The Ellenburger-San Saba Aquifer is classified as a Class Ib aquifer under the DOT system that describes it as highly vulnerable to contamination. This aquifer system is also representative of karst and solution features that qualify outcrops as vulnerable. The Texas DRASTIC map also rates these outcrops with an index greater than 110.

Marble Falls Aquifer. The Marble Falls Aquifer occurs in several separated outcrops, primarily along the northern and eastern flanks of the Llano Uplift. It provides water to parts of Blanco, Burnet, Lampasas, McCulloch, and San Saba counties, and to smaller parts of Kimble, Llano, and Mason counties in central Texas. The Marble Falls Aquifer is classified as a Class Ib aquifer under the DOT system that describes it as highly vulnerable to contamination.

Edwards-Trinity Aquifer. The Edwards-Trinity Aquifer underlies the Edwards Plateau east of the Pecos River and the Stockton Plateau west of the Pecos River, providing water to all or parts of 38 counties. The aquifer extends from the Hill Country of central Texas to the Trans-Pecos region of west Texas. The Edwards-Trinity Aquifer is classified as a Class Ib aquifer under the DOT system that describes it as highly vulnerable to contamination. The portions of this aquifer system that are composed of outcrops of the Washita Group Limestones are considered karst areas.

Cenozoic Pecos Alluvium Aquifer. The Cenozoic Pecos Alluvium Aquifer, located in the upper part of the Pecos River Valley of west Texas, provides water to parts of Andrews, Crane, Ector, Loving, Pecos, Reeves, Upton, Ward, and Winkler counties. The Cenozoic Pecos Alluvium Aquifer is classified as a Class Ia aquifer in the DOT system because of the highly transmissive nature of the unconsolidated sediments of the region. All stream drainages and their associated watersheds are considered primary recharge areas. The surficial alluvial deposits of the Pecos River Valley are considered vulnerable due to the DRASTIC index exceeding 110.

Dockum Aquifer. The Dockum Aquifer is not considered vulnerable for the purposes of this investigation; it does not outcrop along the Longhorn pipeline route and is generally not considered a public water supply.

Capitan Reef Complex Aquifer. The Capitan Reef Complex Aquifer is not considered vulnerable for the purposes of this investigation; it does not outcrop along the Longhorn pipeline route and is generally not considered a public water supply.

Rustler Aquifer. The Rustler Aquifer is not considered vulnerable for the purposes of this investigation; it is generally not considered suitable for either domestic or public water supply.

Hueco Bolson Aquifer. The Hueco Bolson Aquifer is located in El Paso and Hudspeth counties in the far western tip of Texas. Although it is generally under water-table or semi-confined conditions, it is not considered vulnerable because of an extremely slow infiltration rate from the surface downward.

Lipan Aquifer. The Lipan Aquifer is located in the Lipan Flats area of eastern Tom Green County, western Concho County, and southern Runnels County. The Lipan Aquifer is classified as a Class Ia aquifer under the DOT system as it is highly permeable. However, because the quality of the water is generally not suitable for public supply, it is not considered vulnerable for the purposes of this investigation.

4.2.1.1.2 Description of Ground Water Use in the Vicinity of the Pipeline

This section describes the use and relative dependence upon ground water for public supply along the existing System route. Seventeen municipal water systems that use ground water as a primary source or to provide a significant portion of supply are located within 2.5 miles of the System and are listed in Table 4-11a. An additional seven public water supply systems utilizing ground water are within 2.5 to 25 miles of the System and may be at risk from a release of refined petroleum product. These systems are listed in Table 4-11b. In all, the pipeline route crosses 22 counties. The ground water resources available within each county are described in Table 4-12.

4.2.1.1.3 Vulnerability of Selected Aquifer Reaches

Several aquifers along the System route have been identified as particularly vulnerable to contamination by a spill of refined petroleum product on their recharge areas. These aquifers include (1) the Edwards Aquifer (BFZ)-Barton Springs Segment, (2) Colorado River Alluvium Aquifer (proposed), and (3) Edwards-Trinity Aquifer. To a lesser extent, several aquifers warrant detailed discussion of vulnerability to a release of a refined petroleum product upon their recharge zones. These aquifers include: (1) Carrizo-Wilcox Aquifer, (2) Queen City and Sparta aquifers, and (3) Cenozoic Pecos Alluvium Aquifer.

Barton Springs Segment of the BFZ

The Barton Springs Segment of the Edwards Aquifer (BFZ) is a subdivision of the Edwards Aquifer. This TWDB-designated major aquifer (Ashworth and Hopkins, 1995) occurs along the front of the uplifted Edwards Plateau physiographic province (Carr, 1967) extending from near Brackettville in Kinney County to the Lampasas River in Bell County. The Edwards Aquifer (BFZ) is a hydrogeologic unit occurring in both confined (artesian) and unconfined (water-table) conditions. The lithologic units that comprise the aquifer system are early- to mid-Cretaceous in age consisting primarily of limestones and dolomitized limestones. These formations were uplifted and tensionally fractured during the Miocene Epoch of geologic time, thus developing the lithology to enable the occurrence of a unique, highly transmissive, high-quality aquifer system. This aquifer system is subdivided into the San Antonio Segment, Barton Springs Segment, and Northern Segment (Senger et al., 1990). For the purposes of this investigation, only the Barton Springs Segment is discussed.

The Barton Springs Segment of the Edwards Aquifer (BFZ) is generally defined as occurring in the Kainer, Person, and Georgetown formations of the Edwards Group limestones in the San Marcos Platform structural province (Small et al., 1996). The Barton Springs Segment of the aquifer extends from a general ground water divide in Hays County near Onion Creek in the southwest to a ground water divide in Travis County coinciding with the Colorado River.

The aquifer is limited down dip (southeast) by a water-quality limit of 1,000 milligrams per liter (mg/L) total dissolved solids, approximately paralleling I-35 and up dip (northwest) by the Mount Bonnell Fault at the limit of the Kainer Formation outcrop.

The System crosses the Edwards Aquifer (BFZ) in southern Travis County. Figure 4-9a shows detailed geology for the area. The pipeline route runs generally normal to faults in the extensively fractured BFZ. Figure 4-10 shows a cross-section of the Edwards Aquifer in the area of the System route.

The Edwards Aquifer (BFZ) outcrop in the vicinity of the pipeline route is subdivided into eight separate hydrogeologic units (Rose, 1972). These units, numbered I to VIII from bottom to top of the aquifer are shown on Figure 4-11. The hydrogeologic units that are generally the most transmissive (and thus, most vulnerable) are Unit III (Leached and Collapsed Member – Undivided) and Unit VI (Kirshberg Evaporite Member). These primary aquifer units are most prone to the formation of karst features (R. J. Brandes Company, 1999). Conversely, the least transmissive units in the aquifer system are Unit I (Georgetown Formation) and Unit VIII (Basal Nodular Member). Generally, these two units function as vertical barriers to ground water movement and are confining units in most locations (except where extensively fractured). The remaining units (II, IV, V, and VII) occur with moderate transmissivity and thus are moderately vulnerable to contamination. Figure 4-9b shows the geologic units of this aquifer aggregated into areas of similar vulnerability.

It can be easily stated that wherever an outcrop of Unit III or VI occur, there is a very high potential for rapid infiltration of mobile fluid media (such as water or refined petroleum products). An increased potential for infiltration from the surface occurs in these two units in areas where karst features are developed. Generally, the presence of a known karst feature indicates the presence of an order of magnitude increase in the presence of unknown subsurface features that rapidly transmit ground water with little or no filtration (Veni, 1999). Karst features in the Barton Springs Segment have been extensively documented by such organizations as the Texas Speleological Survey. They indicate a high density of karst features in association with Unit III or VI. (These features are not shown on figures in this report for conservation reasons and at the request of the Texas Speleological Survey.) In the vicinity of the System route, numerous karst features occur in designated "Karst Preserves." Karst preserves are natural areas designated by the City of Austin for conservation purposes.

The Barton Springs/Edwards Aquifer Conservation District (BS/EACD) in Austin, Texas, conducted dye-tracer tests in several recharge features that were suspected of contributing significant recharge, as shown on Figure 4-12, to the flow of Barton and associated springs (Hauwert et al., 1998). These tests aided in the development of a conceptual hydrogeologic model which indicated rapid ground water movement in Barton Creek and Williamson Creek watersheds that emerged at Barton and associated springs. Ground water movement in this area ranged from 0.07 to 4 miles in 24 hours. The flowpaths which were generally northeastward toward Barton and associated springs are shown on Figure 4-12.

Edwards-Trinity Aquifer

The Edwards-Trinity Aquifer is one of the largest aquifer systems in Texas occurring in 38 west-central Texas counties. This aquifer system is present in the Edwards Plateau physiographic province of Texas (Carr, 1967). The Edwards-Trinity Aquifer is comprised of geologic units of early-Cretaceous age that includes members of the Trinity, Fredericksburg, and Washita groups. The saturated thickness of the aquifer varies from approximately 100 to 500 ft (Barker and Ardis, 1996).

The System crosses the Edwards-Trinity Aquifer in a route that enters in northern Gillespie County, runs generally northwest and exits in western Upton County. In Gillespie and Mason counties, the route intermittently crosses the outcrops of Fredericksburg Group limestones alternating across the outcrops of Ellenburger-San Saba Aquifer and Hickory Aquifer. Once within northeastern Kimble County and to the west northwest, the route crosses outcrops of Segovia Limestone, with intermittent caps of the overlying Buda Limestone.

As the route continues to the west through Menard, Schleicher, Crockett, Reagan, and Upton counties, the aquifer system becomes progressively thinner, exposing outcrops of the basal Cretaceous sands such as the Cox Sandstone and Maxon Sand. However, for the purposes of assessing vulnerability to contamination, the pipeline route exits outcrops of limestone and the karst vulnerable areas in the vicinity of south-central Reagan County near the town of Big Lake. West of Big Lake, the potential for karst feature formation is negligible.

Karst feature formation has been documented in the region of the Edwards-Trinity Aquifer. An inventory of karst features in the vicinity of the System route within the Edwards-Trinity Aquifer was conducted by Veni (1999) from Texas Speleological Survey records. The inventory indicates the presence and potential of karst features across the Edwards Plateau region at any location where there is an outcrop of limestones that are generally soluble and karst forming. The occurrence of such features is seemingly not as great as in the Edwards Aquifer (BFZ). This may only be so because the degree of study in the Edwards Plateau region has not been as intense as in the BFZ area. Therefore, the potential vulnerability of ground water resources in the region may be quite high. The majority of domestic and stock use in the region relies solely upon ground water resources. There are also several public water supplies that may be at risk from contamination of this aquifer system.

In Tables 4-11a and 4-11b several municipalities and public water supply systems have been identified that may be vulnerable to a release from the System. Because this region has a relatively high potential for karst feature formation, the typical method of applying the DRASTIC methodology to the evaluation of ground water resource vulnerability is probably inappropriate. The DRASTIC methodology tends to yield inconsistent results in karst regions (Sendlien, 1992). The most appropriate method for identifying focused vulnerable areas in this region would be the delineation of wellhead protection areas (Veni, 1999). No delineated wellhead protection areas have been identified in this region. This method would permit the source area for each public supply well or well field to be defined. Given the current level of study performed on this region, relative sensitivities within the region can only be inferred from available information on karst feature location.

Colorado River Alluvium Aquifer

The Colorado River Alluvium Aquifer is a narrow band of continuous, hydraulically interconnected fluvial terraces and alluvial sediments that are deposited along the course of the Colorado River Valley extending from Wharton County in the southeast to Travis County in the northwest. This aquifer system occurs within the Gulf Coastal Plain physiographic province (Carr, 1967). The total mapped area of this aquifer is approximately 14,500 acres in five counties including Wharton, Colorado, Fayette, Bastrop, and Travis. The Colorado River Alluvium Aquifer consists of alluvial deposits of rounded sand and gravel primarily composed of quartz and chert.

The Colorado River Alluvium Aquifer is in direct hydraulic connection with the Colorado River. Consequently, the water-table fluctuates in direct response to the river stage (Saunders, 1996). The aquifer occurs in water-table conditions with moderate hydraulic conductivity, receives recharge from the river during periods of high base flow (April - October), and loses water to the river from bank storage during low base flow (November - March).

This aquifer is an important ground water resource in the region used for both public supply and irrigation. The Colorado River Alluvium supplies several municipalities including the cities of Bastrop, Manor, and Garfield. There are several other water purveyors that include

Travis County Municipal Utility District #2, Manville Water Supply Corporation, The Colony in Austin, and River Timbers development. Water quality in this aquifer is similar to the Colorado River and is correspondingly high.

The System crosses the Colorado River Alluvium intermittently in Fayette and Bastrop counties. A listing of intervals crossed is contained in Section 4.2.1.2.2. The pipeline system crosses the aquifer at nine separate intervals inclusive between MP 100.0 and MP 167.0 for a total crossing mileage of approximately 25.5 miles. Spills from the pipeline into Onion Creek (a tributary of the Colorado River) or into tributaries of Onion Creek could potentially impact 15 public water supply wells in the Colorado River Alluvium downstream. Spills from the pipeline at the point where the pipeline crosses the Colorado River mainstem would have relatively little impact to public water supplies, as there are no public water supply wells located in the Colorado River Alluvium downstream of the crossing. The potential for contamination is, however, dependent upon stage of the river, rising or falling, and discharge rate at each public supply well site.

Carrizo-Wilcox Aquifer

The Carrizo-Wilcox Aquifer of Texas occurs in the outcrop as a 5- to 15-mile-wide band of interbedded sands and clays extending from the Rio Grande in the southwest to the Sabine River in the northeast. The Carrizo-Wilcox Aquifer system is composed of the Hooper Formation, Simsboro Formation, and Calvert Bluff Formation of the Wilcox Group, and the Carrizo Sand of the Claiborne Group. The Carrizo Sand and the Simsboro Formation are the primary aquifer units in this series of fluvial-deltaic deposits of Eocene age.

The Carrizo-Wilcox Aquifer in the vicinity of the System occurs in Bastrop County south of the Colorado River. In the area where the pipeline crosses the Carrizo Sand, the Colorado River has downcut into the substrate and filled with the Colorado River Alluvium. In this area, the Colorado River Alluvium may be in hydraulic connection with the Carrizo Sand. The upper Wilcox Group or Calvert Bluff Formation equivalent effectively isolates the underlying Simsboro Formation hydraulically from both the Colorado River Alluvium and the Carrizo Sand. The crossing of the Calvert Bluff Formation is of little or no consequence. The Simsboro Formation, which is moderately transmissive, is crossed by the pipeline north of Cedar Creek. There is a moderate risk to the aquifer in this area in the event of a release. The development of deep soils in this area generally reduces the risk of serious contamination. No public supply wells in this area are known to be completed in the Colorado River Alluvium or other hydraulically connected units of the Carrizo-Wilcox Aquifer.

The Carrizo-Wilcox Aquifer is generally concluded to be at a low to moderate level of risk to a spill in the vicinity of the System. R. J. Brandes Company (1999) estimated that a spill could migrate 10 to 200 ft per year depending upon the type of product released.

Other Aquifers Crossed by the System

The System crosses several additional aquifers along the existing route that are not discussed in detail. These aquifers include Sparta, Queen City, Trinity, Ellenburger-San Saba, Hickory, Marble Falls, Cenozoic Pecos Alluvium, Dockum, Capitan Reef Complex, Rustler, and Hueco Bolson. With the exception of the Cenozoic Pecos Alluvium and the Hueco Bolson, all the aquifers listed are minor aquifers. With certain exceptions based upon the presence of such features as karst and springflow or public water supply, the majority of these aquifer systems are classified with a relatively low vulnerability to the System route.

4.2.1.1.4 Ground Water Springflow in the Vicinity of the System

The presence of springflow in the vicinity of the pipeline may indicate that ground water recharge is occurring nearby or within the local watershed, although it is also possible that the recharge is occurring at a remote location. Along the route of the System, a number of ground water springflow sites have been identified as sites potentially affected by a release of refined petroleum products. These are identified in Table 4-13.

One of the characteristics of ground water flow in karst areas is the presence of springflow. The sites identified in Table 4-13 are all within karst areas with the exception of Burleson Spring that issues from alluvium in the Wilcox Group of sediments.

4.2.1.2 Identification of Environmentally Vulnerable Areas for Ground Water

In this section, the information reported in Section 4.2.1.1 is used to delineate environmentally vulnerable reaches along the pipeline. This delineation was performed at two levels of study, an initial level and a detailed level. The initial level of delineation was discussed in Section 4.2.1.1. Major/minor aquifers were each placed into relatively vulnerable and invulnerable categories, based upon a general review of aquifer geology and the ground water use in the region of the aquifer. This process identified a number of aquifers as being vulnerable, and information was provided in Section 4.2.1.1.3 to allow for a more detailed subdivision of the pipeline route across the vulnerable aquifers into relative vulnerable and invulnerable intervals. This additional information is used in this section to allow for ranking of aquifer vulnerability across the full length of the pipeline route.

4.2.1.2.1 Data Used

The data used for the initial division of major and minor aquifers into relative vulnerability categories include:

- TWDB database of major and minor aquifers;
- The Geologic Atlas of Texas, 1:250,000 (The University of Texas – Bureau of Economic Geology [BEG]);
- TWDB reports and studies conducted at the county-level scale;
- US Geological Survey (USGS)– Regional Aquifer Systems Analysis for Edwards-Trinity and Gulf Coast aquifers;
- USGS Water-Resources Investigations Reports (various) and miscellaneous other USGS reports for the region; and
- Texas Natural Resource Conservation Commission (TNRCC) DRASTIC map (general) of Texas 1:250,000.

The data used for the subdivision of the pipeline crossings of vulnerable aquifers into intervals of relative vulnerability include:

- Detailed geologic mapping (where available) at 1:24,000 scale. Sources included USGS, BEG, BS/EACD, and the Lower Colorado River Authority (LCRA).
- Karst feature mapping provided by The University of Texas –Texas Memorial Museum and BS/EACD.
- Review of conceptual flowpath model and dye injection tracer studies for portions of the Edwards Aquifer (BFZ) – Barton Springs Segment conducted by BS/EACD.
- Review of TWDB and TNRCC water well database for each of the counties along the System route.
- Data provided by interested parties (see Appendix 4F).
- Review of all available and applicable geographic information system (GIS) data from local, state, and federal government entities with jurisdiction along the System route. These entities include Harris-Galveston Coastal Subsidence District, Houston-Galveston Area Council, USGS, Guadalupe Brazos River Authority, LCRA, BS/EACD, City of Austin, TWDB, TNRCC, and the Texas Natural Resources Information System (TNRIS).
- Interviews with technical staff members of selected underground water conservation districts and water utilities along the pipeline route, and state and federal governmental agencies that have conducted hydrogeologic research in the regions crossed by the System. These entities include: Harris-Galveston Coastal

Subsidence District, USGS, BS/EACD, LCRA, Colorado River Municipal Water District, TWDB, TNRCC, and City Public Service/El Paso Water Utilities Board.

- Review of information provided as comments to the draft EA.

4.2.1.2.2 Identification of Vulnerable Intervals

This section describes methodology for determining the degree of vulnerability of ground water resources along the route of the System. A set of criteria was selected that would methodically, comprehensively, and progressively identify vulnerable areas (with regard to ground water resources) along the pipeline route. These criteria are:

- DRASTIC Index;
- Identification of karst aquifer areas;
- Proximity to public water supply intakes (ground water); and
- Application of the DOT method for classification of USAs. Filter criteria of this method were not applied because no source area delineations have been conducted on studied well fields.

Criteria for Estimating Relative Ground Water Resource Vulnerability

The criteria for the estimation of ground water resource vulnerability along the System route are described in this section in order of the application methodology. The approach for estimating relative ground water resource vulnerability is based upon the criteria previously listed. The relative vulnerability of ground water resources to a pipeline spill was estimated in two ways: (1) Hydrogeologic Vulnerability - the environmental vulnerability of aquifer based on hydrogeologic factors (how easily the aquifer would become contaminated by a spill and how difficult it would be to remediate); and (2) Proximal Vulnerability - the proximity and importance of public water supply wells (receptors).

Hydrogeologic Vulnerability – Hydrogeologic vulnerability for reaches of the pipeline across aquifers was ranked qualitatively from 1 (most vulnerable) to 5 (least vulnerable). In general, non-karst aquifers with DRASTIC ratings (explained below) above 110 were assigned a minimum vulnerability of 3. Karst aquifers were assigned a minimum vulnerability of 3. Non-karst aquifers with DRASTIC ratings below 110 were assigned sensitivities of 4 or 5, based upon their hydrogeologic characteristics (discussed in Section 4.2.1.1). Aquifer reaches with a minimum vulnerability of 3 were assigned a higher vulnerability (2 or 1) based upon relative vulnerability of the individual geologic units traversed or proximity to known karst features. The application of these criteria to vulnerability ranking is explained in more detail below.

- DRASTIC Methodology

    - DRASTIC (EPA, 1987) is a classification methodology of ground water systems developed by EPA. The purpose of DRASTIC is to generally assess a ground water aquifer or aquifer system for its susceptibility to pollution from surface sources by the use of hydrogeologic factors. DRASTIC is an acronym that is defined as follows: D = Depth to ground water; R = (net) Recharge; A = Aquifer media; S = Soil media; T = Topography (slope); I = Impact of vadose-zone media; and C = Conductivity (hydraulic) of the aquifer. The DRASTIC methodology determines a non-dimensional value or "index" that is used to qualitatively and relatively assess the vulnerability of a selected aquifer system. DRASTIC indices are used as a general guideline only for evaluating the susceptibility to contamination for a given aquifer. For the purposes of this investigation, an index value of 110 was selected as the threshold above which an aquifer system is considered generally vulnerable. This threshold was selected based upon criteria described in Texas Administrative Code, Title 30, Section 210.23. An index greater than or equal to 110 is considered vulnerable in the initial review. DRASTIC is a useful tool in the assessment of porous-media aquifers. When applied to karst aquifer systems, DRASTIC tends to be too conservative or can generally underestimate the vulnerability of such aquifers. If an aquifer or aquifer system was identified on the previously described data sources as exhibiting karst topography or characteristics, it was automatically assigned a minimum vulnerability value of 3.

- Karst Areas

    - Regardless of the DRASTIC index, if the aquifer area in study is identified as exhibiting karst topography or other karst characteristics, then it is initially assigned a minimum vulnerability value of 3. Karst, as previously described in this report, is a geomorphologic term that indicates that the characteristic land surface topography has sinkholes, caves, little or no perennial streams, and disappearing streams on a soluble bedrock substrate (usually limestone). In karst areas, these characteristic features were inventoried from available sources (TSS) within 25 miles normal to the System route. Each feature was assessed qualitatively based on its topographic position on USGS 7.5-minute quadrangle maps (1:24,000), considering proximity to surface drainage.

Criteria for vulnerability rankings of 1 or 2. Vulnerability rankings of 1 or 2 were assigned to pipeline reaches crossing karst, based upon detailed geologic maps (1:24,000 scale) or proximity to a known karst feature. These rankings were reserved for karst areas because of the relative difficulty of controlling spill migration within a karst aquifer versus a typical sand/gravel aquifer. If a detailed geologic map of a karst area showed a traversed geologic unit that was highly porous, the unit was assigned a vulnerability of 1. An example of such a geologic unit is the Person Formation – (Leached and Collapsed Member-undivided) which is a very high permeability hydrogeologic unit with karst features. If a detailed geologic map of a karst area showed a traversed geologic unit that was moderately porous, the unit was assigned a vulnerability of 2. An example of such a geologic unit is the Kainer Formation - Grainstone Member.

Proximity to known karst features (sinkholes, caves, springs, etc.) was estimated from the best available data sets. These features were inventoried from available sources (Veni, 1999; Russell, 1999) in the vicinity of the System route and plotted on the project GIS database. The location of each karst feature relative to the potential path of overland flow from a pipeline spill was reviewed. If the karst feature was within or immediately adjacent to a potential path of overland flow, the reach of the pipeline from which the overland flow was estimated to originate was assigned a vulnerability of 1. Otherwise, if the karst feature was within 2.5 miles (upstream or downstream) of the pipeline, the reach of pipeline nearest the karst feature was assigned a vulnerability value of 2.

The resulting vulnerability rankings along the pipeline are presented in Table 4-14.

Vulnerability with respect to public water supply. The ground water resources were also ranked relatively (1 – most vulnerable to 5 – least vulnerable) with respect to importance as a water supply resource. This ranking was based upon comparison of the proximity of public water supply wells to the pipeline (i.e., distance to a well), and of the depth and geologic unit in which the wells were installed (i.e., time in which spill could impact a well). The general method used was to use the TWDB and TNRCC public water supply well GIS databases to plot well locations in relation to the pipeline trace. Additional wells identified during the public comment process were also considered. Wells completed in alluvial formations were differentiated from wells completed in deep aquifer formations. The importance of wells as a sole or large source of public water was estimated from review of data provided and reports reviewed. See Tables 4-11a and 4-11b.

The criteria applied for public water supply vulnerability were as follows ("wells" refer to public water supply wells only):

- If a shallow (alluvial) well or a well within known karst terrain was located within 2.5 miles of the pipeline, the reach of pipeline nearest the well was assigned a rank of 1 or 2. The choice of 1 or 2 was made based on importance of the well as a sole or large source of public water.

- If a shallow (alluvial) well was located along a stream feature downstream of the pipeline within 25 miles of the pipeline, the reach of pipeline nearest the well was assigned a rank of 3 or 4. The choice of 3 or 4 was made based on importance of the well as a sole or large source of public water.
- If a well within known karst terrain was located downgradient of the pipeline within 25 miles of the pipeline, the reach of pipeline nearest the well was assigned a rank of 3 or 4. The choice of 3 or 4 was made based on importance of the well as a sole or large source of public water.
- If a deep (non-alluvial) well was located within 2.5 miles of the pipeline, the reach of pipeline nearest the well was assigned a rank of 3 or 4. The choice of 3 or 4 was made based on importance of the well as a sole or large source of public water.
- If there were no alluvial or karst terrain wells within 25 miles of the pipeline, or any deep wells within 2.5 miles of the pipeline, the reach of pipeline was assigned a rank of 5.

It should be noted that the choices of 2.5 miles and 25 miles as distances from the pipeline to use for ranking criteria were made based upon a combination of professional judgment and the ranges of the data reviewed. The data reviewed are summarized in Section 4.2.1.2.1. The distances fit with known physical facts concerning flow within aquifers (e.g., flow within karst is faster than through sand/gravel aquifers) and also allow for differentiation between pipeline reaches. These distances are not fixed estimates of potential migration distances through ground water from the pipeline. The purpose of their application is relative ranking of pipeline reach vulnerability, not identification of individual at-risk wells from potential spills.

Summary of Ground Water Vulnerability

The ranking for hydrogeologic vulnerability and the ranking for vulnerability to public ground water supplies were added to estimate an overall relative risk ranking for reaches of the pipeline. Rankings are summarized in Table 4-14.

4.2.1.2.3 Identification of Vulnerable Ground Water Intervals for the Odessa Lateral

The route for the Odessa Lateral is depicted on Figure 4-7. The identification of pipeline intervals along this route that have vulnerable ground water resources followed the same methodology as described in the previous section (Section 4.2.1.2.2). The ranking for hydrogeologic vulnerability and the ranking for vulnerability to public ground water supplies and the total of these two rankings are presented in Table 4-14. The MPs in this table start at MP 0 at the southern junction with the existing route, and increase to MP 28.0 at the terminus of the lateral. The sums, which are eight for each of the two described reaches of aquifer traversed, are directly comparable to the similar sums presented in Table 4-14.

The first 25.8 miles of the lateral traverse Cenozoic Pecos Alluvium; the final 3.2 miles traverse the Edwards-Trinity Aquifer. There are 13 shallow public water supply wells in the Cenozoic Pecos Alluvium about 4.8 miles to the west of the lateral, outside of and parallel to the surface drainage (Landreth Draw) in which the lateral is located. There are numerous (over 130) public water supply wells screened at depths varying between 220 and 300 ft that are between 13 and 20 miles to the east and north of the north terminus of the lateral. This region of the Edwards-Trinity Aquifer does not have tendencies toward karst development, because of the relatively thin occurrence of limestone in the area (20 to 30 ft). The rate of transport within the aquifer is on the order of less than 10 ft per year.

4.2.1.2.4 Identification of Vulnerable Ground Water Intervals for the Austin Re-route Alternative

The Austin Re-route Alternative is depicted on Figure 4-5. The identification of pipeline intervals along this route that have vulnerable ground water resources followed the same methodology as described in the previous section (Section 4.2.1.2.2). The ranking for hydrogeologic vulnerability, the ranking for vulnerability to public ground water supplies, and the total of these two rankings are presented in Table 4-15. The MPs in this table start at MP 0 at the eastern junction with the existing route, and increase to MP 21.02 at the western junction with the existing route. The sums, which vary from 3 (most vulnerable) to 10 (least vulnerable), are directly comparable to the similar sums presented in Table 4-14.

The re-route (21 miles in length) bypasses 12 miles of the existing pipeline. The highly vulnerable (hydrogeologic vulnerability rank of 1 in Table 4-14 or Table 4-15) reach traversed by the re-route is slightly shorter than that traversed by the existing pipeline (1.1 miles versus 1.3 miles). The length of vulnerable aquifer (hydrogeologic vulnerability rank of 3 or less in Table 4-14 or Table 4-15) traversed by the re-route is significantly longer than the existing pipeline (8.2 miles versus 2.9 miles).

4.2.2 Surface Water

4.2.2.1 Description of Surface Water Resources

The Longhorn pipeline intersects the following major river basins, from east to west: San Jacinto River, Brazos River, Colorado River, Pecos River, and Rio Grande. This section identifies the streams crossed by the pipeline and defines the characteristics relevant in comparing stream size, water quality, and use (i.e., public water supply and irrigation).

The pipeline crosses 288 streamlines using USGS 1:100,000 hydrography. Sixty-one of the streams crossed are of second-order or higher (meaning the streams are downstream of a junction of at least two streamlines). The pipeline crosses the mainstem of the Brazos River, Colorado River, Pedernales River, Llano River, and Pecos River. A number of significant tributaries of these rivers are also crossed: James River (Llano), Onion Creek (Colorado), Cottonwood Creek (Upper Pecos), and Antelope Gulch (which drains to the West Texas Salt Basin). Each tributary has a basin area exceeding 200 square miles upstream of the pipeline. The watersheds upstream of the pipeline for each of the second-order (or higher) streams crossing the pipeline are delineated in Figures 4-13a and b. The basin areas of the bayous in Harris County (White Oak Bayou, Green Bayou, Halls Bayou, and Hunter Bayou) were not delineated and are represented in later tables by data collected from nearby flow/water quality gauges. The crossings are numbered (including the first-order crossings) in increasing order from east to west.

4.2.2.1.1 Description of Significant Stream Crossings Along Route

A brief description of individual major streams crossed by the pipeline follows.

Greens Bayou. The Longhorn pipeline crosses Greens Bayou in Harris County, approximately 7 miles from the Galena Park Station. Greens Bayou is channelized with sloping banks that contain very little native vegetation and are mainly covered with bermuda grass. The water is slow-moving over a bottom substrate partially composed of gravel and silt.

White Oak Bayou. The pipeline crosses White Oak Bayou in Harris County, approximately 32 miles from the Galena Park Station. White Oak Bayou is a completely channelized body of water. The banks are steeply sloped and covered in bermuda grass. There is very little native vegetation near the channel. Water flow is slow but constant.

Cypress Creek. The Longhorn pipeline crosses Cypress Creek in Harris County, 48 miles from the Galena Park Station. Cypress Creek is partially channelized due to the installation of flood control measures. Vegetation in the vicinity of the creek consists primarily of native cypress, the creek's namesake.

Brazos River. Brazos River is crossed at the Waller-Washington county line, approximately 65 miles from the Galena Park Station. The Brazos River is a slow-moving, meandering river with turbid water and a silt-dominated substrate. Its tree-lined banks are relatively wide and steep. The river supports many fish species and is a popular location for recreational fishing.

Colorado River. While passing through Bastrop County, the pipeline crosses the Colorado River, 136 miles from the Galena Park Station. Generally, the Colorado River is a wide and slow-moving flow over a substrate of silt. The riverbanks are lined with willow, cottonwood, pecan, elm, and sycamore trees, which help to prevent erosion and provide excellent cover for fish.

Onion Creek. Onion Creek is crossed in Travis County, 167 miles from the Galena Park Station. The creek flows through both the Edwards Plateau and the Blackland Prairies regions. In the Edwards Plateau region, the banks of Onion Creek are limestone and lined with bald cypress, sycamore, cottonwood, American and cedar elm, and pecan trees. In the Blackland Prairie natural region, the vegetation remains the same, but the banks are more erodable due to deeper soils.

Barton Creek. The pipeline crosses Barton Creek in Travis County, 184 miles from the Galena Park Station. Barton Creek is spring-fed with limestone banks and substrate. The creek flows between multiple pools and riffles throughout its length. The banks are vegetated with bald cypress, sycamore, cottonwood, American and cedar elm, and pecan trees, and the creek provides good habitat for numerous fish species.

Pedernales River. The Pedernales River is crossed in Blanco County, approximately 202 miles from the Galena Park Station. The Pedernales River is generally shallow and flows clear along rocky banks that are lined with bald cypress and cottonwood trees. Flows of this river can increase dramatically after a heavy rain.

Llano River. The pipeline encounters the Llano River in Kimble County, near MP 281. The river is spring-fed and flows over limestone and gravel substrate, which produces many small riffles. Limestone banks vary in slope and are lined with trees and dense vegetation. The river provides excellent habitat for fish with abundant cover and shade. Although the Llano

River produces one of the best fisheries in Texas, it is relatively under-utilized due to limited access.

Upper Pecos River. The western most significant surface water body crossed by the Longhorn pipeline is the Upper Pecos River. The pipeline crosses the river at the Ward-Reeves county line, approximately 535 miles from the Galena Park Station. The Upper Pecos River is sluggish, flowing through a narrow and shallow channel. The water is slightly saline due to the soils and saline ground water seeps and springs that drain into the river. The salinity of the river creates a unique habitat for certain fish species.

4.2.2.1.2 Streamflow Regime at Pipeline Crossings

Summary data from selected USGS flow gauges in the vicinity of the stream crossings are presented in Table 4-16. These records show the following:

- There is generally a wide variation in flow regime throughout the year, with low flows (those flows exceeded 90 percent of the time) being a small fraction of mean and median flows for the smaller, unregulated streams.
- Extreme historic flows can be very large, relative to the size of the watershed.

A study of the major basins contributing to the Gulf of Mexico (Dunn, 1996) included a search for statistically significant increases in streamflow. White Oak Bayou (which is crossed by the pipeline) was found to have a statistically significant increase in streamflow because of urbanization. This trend was on the order of a 1,600 acre-ft increase per year, based on a significance level less than 0.05. The other relevant streams studied (Colorado River and Brazos River) showed no significant trends in streamflow.

The basin area upstream of the pipeline crossing and stream slope at pipeline crossing for each of the second-order stream crossings are presented in Table 4-17. Using these parameters and others, extreme flows can be estimated for these watersheds (Asquith, et al., 1997; Asquith, 1998; Asquith, et al., 1996; Rines, 1998). The most conservative (highest value) flood estimate for each watershed using these various methods is presented in Table 4-17. The two-year flood in this table is a reasonable estimate of the mean annual flood, which in alluvial channels generally defines the size of channel bankful storage. The potential for scour at stream crossings along the pipeline route is discussed in Section 4.2.3.3.

In the karst terrain of the Edwards Aquifer (BFZ) and the Edwards-Trinity Aquifer, there are complex regional interactions between surface and ground water. In this area, surface water can enter local karst features, pass rapidly through subterranean solution zones, and re-emerge in surface springs miles downstream. This interaction, with a particular focus on the region near the Barton Creek pipeline crossing, is discussed in Section 4.2.1.1.3.

4.2.2.1.3 Water Quality Downstream of Pipeline Crossings

Surface water quality sampling sites downstream of the pipeline were identified using the EPA database, STORET. Sites were selected which were the closest to the pipeline crossings and that had significant analyses since 1985. The locations for these sites are shown in Figures 4-14a and b. The inorganic and coliform analytical data for each of these sites were aggregated as averages into Table 4-18a. This table is intended for relative comparisons of general water quality along the route, and the averaging was performed without detailed review of the data. Measurements reported as equal to the analytical detection limit were included in the averages. Outliers more than two standard deviations from the statistical mean were not included in these averages.

In general, the table shows the Pecos River and Rio Grande higher in dissolved solids (including chlorides) than elsewhere along the route. Nitrogen and phosphorus levels are higher in the Houston area than elsewhere. The sampled streams near urban areas (Austin and Houston) are high in fecal coliform levels.

The STORET analytical data for total organic carbon (TOC) for selected sites from Figures 4-14a and 4-14b are summarized in Table 4-18b. The contamination sources of the TOCs for the pump stations with higher values cannot be estimated without further testing to differentiate between petroleum hydrocarbon-related sources and other sources.

Sources other than the EPA STORET database may be available for petroleum-related analyses of select streams within the study area. It is unlikely that such data exist for the full range of streams crossed by the pipeline, making a relative evaluation of existing ambient conditions as relates to petroleum-related contaminants difficult to perform for the full length of the pipeline.

Eight stream segments within 25 miles downstream of the pipeline are on the 1999 list of streams with impaired water quality per Section 303(d) of the Clean Water Act. The list of stream segments and the reasons for their inclusion in the list is provided in Table 4-19. Figures 4-14a and b depict the locations of these segments. Tidal segments in Houston within 25 miles of the pipeline were not included in the table or figures.

Trends in Water Quality

In the Brazos and Colorado River basins, the general trend from the upper reaches of the watershed to the lower reaches (near the pipeline) is one of decreasing sulfates, chlorides, and dissolved solids, and of increasing nitrates, nitrites, and phosphorus (Veenhuis, 1992). A study of statewide trends in state water quality data (Schertz et al., 1994) showed an increase in salinity in the Pecos River, attributed to natural discharge of saline ground water into the river in New Mexico. A study of trends in nutrient inflows to the Gulf of Mexico found flow-adjusted nitrogen and phosphorus concentrations in the lower Colorado River (at Wharton) and White Oak Bayou to be increasing, while in the lower Brazos River (at Richmond) there were no discernible trends.

4.2.2.1.4 Identification of Downstream Water Users

To identify potential water users downstream of the pipeline, the TNRCC water rights database (as available from TNRIS) was obtained and imported into the study area GIS. Water rights downstream of the pipeline crossings were identified and included within the mapping, while rights not located downstream of the pipeline were removed. The following tasks were then performed:

- Distances from each pipeline crossing to a river mainstem were measured using GIS techniques.
- Distances between stream junctions on each river mainstem were measured using GIS techniques.
- Individual rights were sited within each of the measured reaches.
- Distances were tabulated and aggregated to each right from each upstream stream crossing.
- Downstream rights were aggregated by use type (i.e., municipal, irrigation, recreation, hydroelectric, industrial, mining, recharge), and water rights amount within distance range downstream of each crossing.
- This information was assembled in tabular form in Table 4-20. (Distances to the mainstem of the Highland Lakes and Town Lake from stream crossings are also shown in this table.)
- The water rights locations were plotted in Figures 4-13a and b with symbols differentiating the right by use type.

The TNRCC database of public surface water supplies identifies numerous additional water users downstream of the pipeline. The locations for these public water users were also imported into the study area mapping, edited to contain only users downstream of the pipeline, and each user location tagged in Figures 4-13a and b with a symbol designating municipal water use. This database was the source for the identification of the location of the numerous water users contiguous to the Highland Lakes. According to information provided by LCRA, communities and other water supply entities dependent upon surface water supplies downstream from the pipeline include Llano, Burnet, Kingsland, Sunrise Beach, Horseshoe Bay, LCRA Ferguson, Marble Falls, Lago Vista, Jonestown, Leander, Cedar Park, Lakeway, Hurst Creek, Austin, Bastrop, LCRA Sim Gideon, LCRA Lakeside, Garwood Irrigation District, and LCRA Gulf Coast (Hauwert, 1993).

The closest surface water supply source to a pipeline stream crossing is the small water right (30 acre-ft) for Pedernales Falls State Park. The next two closest rights are on the Llano and San Saba rivers, and are more substantial, serving the communities of Llano and Menard. There is a large municipal water right on the Brazos River held by the Galveston County Water Authority about 50 miles downstream of the pipeline crossing of the Brazos River. As noted above, the Highland Lakes and Town Lake are the major water supply source for numerous communities along the lakes. The distance from the lakes (that is, the centerlines of Lake LBJ, Lake Travis, or Town Lake) to the closest pipeline stream crossing ranges from about 26 to 35 miles.

In addition, there are a number of shallow public water supply wells located downstream of the pipeline in stream/river alluvium. These include: 24 wells between Town Lake and the pipeline crossing over the mainstem of the Colorado River, within the river alluvium. One of these is along Dry Creek about 8 miles downstream of the pipeline crossing.

4.2.2.2 Surface Water Resources, Including Vulnerable Areas

The purpose of this section is to identify vulnerable surface water resources along the pipeline route. The focus of this evaluation is water supplies, both public water supplies and irrigation supplies, along the route. Recreational, biological, and cultural resources associated with water are discussed in Sections 4.1, 4.3, and 4.4, respectively.

4.2.2.2.1 Data Sources

The primary data sources for this identification of vulnerable surface water resources are: (1) hydrologic and water quality data available from water resource agencies, (2) water rights data maintained and assembled into a spatial database by TNRCC, (3) available topographic mapping, (4) regional water studies for various water resources along the pipeline route, and (5) data provided by interested parties, including comments provided to the draft EA (see Appendix 4F).

The result of this research was a spatial database that includes the following layers:

- 1:100,000 scale streamlines (hydrography);
- Vulnerable geology affecting surface-water transport (karst area contributing and recharge zone boundaries);
- Delineations of watershed areas draining to pipeline crossings;
- Identification of downstream water rights for a variety of uses (primarily municipal, irrigation, mining, and industrial);
- Identification of public water supply sources downstream of the pipeline stream crossings;
- Identification of water quality sampling stations on streams downstream of pipeline stream crossings; and
- Identification of impaired stream segments downstream of the pipeline crossings per the Federal Clean Water Act Section 303(d).

Each layer discussed above has a series of fields associated with the feature (point, polygon, polyline) mapped. For example, each water right mapped in Figure 4-13a is linked to a table which includes columns that individually identify a unique identification number for that right, provides the amount of that annual right (in acre-ft), and states the use of the right (municipal, irrigation, etc.). These databases are incomplete and imperfect and are used in this report as the best indicators of relative significance of pipeline stream crossings. Especially important data, such as location of public water supplies, were collected in redundant fashion, and databases had to be edited to remove duplication. For example, the municipal water rights in the TNRCC database were often the same water source listed in the TNRCC surface public water supply database. The information supplied by LCRA provided a third check on the completeness of this particular database.

Analyses of these data and their aggregation by stream crossing into tabular and map form were discussed in Section 4.2.2.1.

4.2.2.2.2 Identification of Surface Water Vulnerability in Terms of Vulnerability to Spills

Spill Movement Ability Ranking

The pipeline stream crossings were ranked on a scale of 1 (highest) to 6 (lowest) for their ability to transport a spill using the following logic:

- Location on the Pipeline. Annual rainfall across the pipeline length varies by over a factor of four, with over 45 inches of annual rainfall in Houston, over 30 inches of annual rainfall in Austin, and about 10 inches of annual rainfall in El Paso. Watersheds in east Texas have significantly larger baseflows than watersheds of a similar size in west Texas, which typically only flow seasonally. Streams west of the Llano River basin have small baseflows and median flows, and can generally be considered to have less transport power, regardless of tributary basin area upstream of the pipeline, than watersheds to the east.
- Major Crossings. At major river and stream crossings in central and east Texas, where there are significant baseflows, spills are clearly able to move more expeditiously than the bulk of the pipeline crossings. Several large rivers and tributaries (stream order greater than three) occur in this region (Colorado River, Brazos River, Llano River, Pedernales River, James River, and Onion Creek). These streams, plus two streams with very large watersheds (Pecos River, Antelope Gulch) were given a subjective ranking of 1.
- Other Large Watersheds. In addition, there are 13 third-order and above streams in the east/central region that are likely to have relatively more transport power than lesser streams. These streams were given a subjective ranking of 2.
- Mean Annual Flood. The remaining streams (west Texas streams and second-order and below streams in east/central Texas) are ranked by mean annual (two-year) flood. This flood can be estimated by Texas hydrologic region, and watershed parameters (basin area, basin shape factor, and basin slope), per the discussion in Section 4.2.2. Those with relatively high, medium, medium-low, and low two-year floods were assigned subjective rankings of 3, 4, 5, or 6; respectively.

The resulting ranking of streams in terms of relative ability for a spill movement is summarized in Table 4-21. Eight of 71 streams in this table have the highest ability to transport.

Ranking of Ability to Isolate the Spill for Cleanup

The pipeline stream crossings were ranked on a scale of 1 (most difficult to remediate) to 6 (least difficult) for the ability to isolate and cleanup a spill into the stream crossing. The purpose is to differentiate between areas where spills are more likely to be controlled and remediated quickly by emergency response teams versus areas where spills can impact difficult to remediate alluvial sediments or karst aquifers. The ranking of pipeline reaches in the potential for a spill to impact river alluvium aquifers or karst aquifers is addressed in detail in Section 4.2.1.2. Reaches of pipeline ranked in that analysis as crossing highly vulnerable aquifers receive a high rank in this evaluation. The purpose of this ranking is primarily to differentiate between other stream crossings in less vulnerable areas. The factors used in the ranking are as follows:

- Location over Vulnerable Aquifers. Stream crossings within karst or alluvial aquifers with a hydrogeologic vulnerability of 3 are assigned a vulnerability ranking of 2, because of the difficulty in remediating or preventing pollutant spread in these formations. Stream crossings within karst formations with a hydrogeologic vulnerability of 1 or 2 are assigned a vulnerability rank of 1. Hydrogeologic vulnerability is shown in Table 4-14.
- Location Along Pipeline. Per the discussion above, a spill into the mainstem of a river in west Texas will be easier to control than one into a mainstem in east Texas. In the arid portion of the state (defined as the area west of MP 590), the stream crossings are given a risk ranking of 6.
- Distance to a River Mainstem. A number of factors could inhibit remediation if a spill cannot be controlled prior to entering a river mainstem. Mainstems have substantially higher flows (greater transport power) and a greater volume of streambed and bank alluvium (providing greater pore volume for contaminant storage). These major crossings are assigned a vulnerability of 1. In cases where a spill is in the contributing zone of a karst aquifer, the distance from the pipeline crossing to the aquifer recharge zone is used in the ranking. Risk rankings of 2 to 5 were assigned based upon distance to a river mainstem or aquifer recharge zone.

The resulting ranking of streams in terms of relative ability to control a spill is summarized in Table 4-22.

Identification of Surface Water Vulnerability in Terms of Importance as a Water Source

In general, municipal water supply sources, which require water of a higher quality than needed for other uses (e.g., mining, industrial, and irrigation), can be considered more vulnerable than other sources. Because human health is a prime concern, they can also be considered relatively more important than other sources, particularly where the source is the prime source for consumption.

As shown in Table 4-23, the pipeline stream crossings were ranked on a scale from 1 (most important) to 7 (least important) in terms of the importance of the water resource downstream as follows:

- Crossings that have municipal water diversion locations, Highland Lake mainstems, or shallow public water supply wells (in alluvium) within 40 miles downstream are subjectively assigned the highest rank of 1. The closest significant identified water right (above 30 acre-ft) for municipal use is over 30 miles downstream from the pipeline. The Colorado River Alluvium, however, is also a municipal water supply source and subject to immediate impacts if contacted by a spill. Distances to the Colorado mainstem upstream of the river pipeline crossing were considered in this analysis to be distances to a public water supply source. There are no public water supply wells downstream of the Colorado mainstem crossing of the pipeline.
- Crossings that have municipal water diversion locations (or Highland Lake mainstems) within 75 miles downstream are assigned the next highest rank of 2.
- Rankings thereafter are by proximity to the other types of rights (irrigation, industrial, and mining).

The distances used for relative risk rankings were chosen, as a means to differentiate among stream crossings, and are not based upon modeling to determine potential contaminant transport distances. Potential contaminant transport distances vary based upon amount spilled, current stream flows, individual stream hydraulics, local geology, and other factors and were not estimated for this presentation.

The resulting ranking in terms of downstream surface/alluvial ground water importance as a water source is presented in Table 4-23.

4.2.2.2.3 Identification of Vulnerable Reaches for the Proposed Route

The rankings for each crossing performed in the preceding section was assembled into a summary table, Table 4-24. The rankings for each crossing were summed and then sorted, so that the lowest sum is shown at the top of the table. This sum of ranks of three represents the crossings most vulnerable to a spill. The crossings listed thereafter in the table are progressively less vulnerable. As noted above, these rankings do not include an evaluation of the recreational, biological, and cultural resource characteristics of each stream crossing, since these issues are addressed in Sections 4.1, 4.3, and 4.4.

4.2.2.2.4 Identification of Vulnerable Reaches for Odessa Lateral

Identification of surface water resources followed the same methodology as described in the previous section (Section 4.2.2.2.2). There are two stream crossings and two canal crossings within the route. Both stream crossings traverse Landreth Draw, which drains to the south towards the Pecos River, between 18 and 22 miles distant. The ranking of these crossings in terms of ability to transport a spill is presented in Table 4-21. The ranking in terms of ability to isolate a spill for cleanup is presented in Table 4-22. The ranking in terms of importance of the downstream water source is presented in Table 4-23. The sum of these rankings, which are 13 for each of the two crossings, are directly comparable to the similar sums presented in Table 4-24. The MPs in this table start at MP 0 at the southern junction with the existing route and increase to MP 28 at the terminus of the lateral.

There appear to be no public surface water supplies within 25 miles downstream of the lateral. There are 13 shallow public water supply wells in the Cenozoic Pecos Alluvium about 4.8 miles to the west of the lateral, outside of and parallel to the surface drainage of Landreth Draw. The lateral does not appear to be a significant risk to these water supplies.

4.2.2.2.5 Identification of Vulnerable Surface Waters with Respect to the City of Austin Watershed Protection Land

The City of Austin has recently completed watershed protection purchases and easements. These are located largely in the Barton Creek Watershed. Using geospatial data provided by the City of Austin, the existing pipeline and the proposed Austin Re-route Alternative were plotted to determine the location of watershed protection parcels with respect to the pipeline (see Figure 4-16). Three parcels were crossed or abutted by the pipeline ROW, for a total of 1.5 miles.

4.2.2.2.6 Identification of Vulnerable Surface Water Intervals for the Austin Re-route Alternative

Identification of surface water resources followed the same methodology as described in the previous section (Section 4.2.2.2.2). The range of rankings and the criteria for rankings are the same as presented in previous sections. There are 14 stream crossings within the route, all tributaries or the mainstem of Onion Creek. The rankings of these crossings in terms of ability to transport a spill are presented in Table 4-25. The rankings in terms of ability to isolate a spill for cleanup are presented in Table 4-26. The rankings in terms of importance of the downstream water source are presented in Table 4-27. The sum of these rankings is presented in Table 4-28. The sums, which vary from 2 (most vulnerable) to 10 (least vulnerable), are directly comparable to the similar sums presented in Table 4-24. The MPs in these tables start at MP 0 at the eastern junction with the existing route and increase to MP 12.2 at the western junction with the existing route.

The Re-route Alternative bypasses a 12-mile reach of existing pipeline that has six stream crossings, three of which are in a short reach where Boggy Creek meanders across the pipeline. Each of these crossings, with the exception of the Onion Creek crossing, has relatively low potential for spill transport. The rank in potential to control a spill varies from 1 (for Marble Creek and Onion Creek) to 3 (for the other four crossings). All six crossings are upstream of and relatively near important water supplies.

The Re-route Alternative has 14 stream crossings. As with the bypassed reach of existing pipeline, there is one major crossing of Onion Creek. There are four additional crossings with the potential for “medium” and higher flooding, versus none for the bypassed reach, as shown in Table 4-25. As with the bypassed reach, the rank in potential to control a spill varies from 1 (for six crossings, versus 2 for the bypassed reach) to 3. All 14 crossings are upstream of and relatively near important water supplies, although they are significantly further from these supplies than the crossings by the existing pipeline.

4.2.2.3 Wetlands

An inventory of wetlands present within 1,250 ft of the pipeline from Houston to El Paso shows that 951 wetlands, consisting of nearly 4,420 acres, are present within the corridor.

National Wetland Inventory (NWI) maps were evaluated to determine numbers (density per linear mile), types, and (to the extent possible), aerial extent of wetlands that are located within 1,250 ft of the Longhorn pipeline. 1:24,000-scale NWI maps were available for the eastern 600 miles of the pipeline; 1:100,000-scale maps were available along the 94 miles of the Galena Park Station to the El Paso Terminal mainline.

Longhorn pipeline crosses or is within 1,250 ft of 105 riverine and 846 palustrine wetlands from the Galena Park Station in Houston to the El Paso Terminal. The greatest concentration of wetlands along the pipeline (approximately 3.5 to 6.8 per linear mile) is located between MP 30 and MP 175, which includes western Harris County, Waller County, Austin County, Lee County, Fayette County, Bastrop County, and eastern Travis County. The density of wetlands (per linear mile) decreases to a range of approximately 1 to 2 per linear miles between MP 175 and MP 300, which includes western Travis County, Hays County, and eastern Blanco County. West of Blanco County to El Paso, the density of wetlands decreases steadily to an average of less than one per mile.

Analyses of wetland types along the pipeline indicate that approximately 25 percent of the 105 riverine wetlands are along lower perennial streams and 75 percent are along intermittent streams. Approximately 36 percent of the 846-palustrine wetlands along the pipeline are classified by the NWI as open water, 21 percent are comprised of emergent vegetation, and 11 percent are forested. The remaining palustrine wetlands are classified as unconsolidated bottom, aquatic bed, unconsolidated shoreline, or scrub-shrub.

The aerial extent of wetlands was estimated for lower perennial riverine, intermittent riverine, open water palustrine, emergent vegetation palustrine, and forested palustrine wetland groups. When possible, actual acreages were estimated; however, those locations that are too small to estimate acreages were classified as 0.2 acres in size. Results of the analysis indicate that the aerial extent of wetlands within 1,250 ft of the pipeline totals approximately 4,506 acres or approximately 2 percent of the 2,500-ft-wide corridor from the Galena Park Station to the El Paso Terminal. Approximately 490 acres are classified as lower perennial stream (riverine) and 2,620 acres are classified as intermittent stream (riverine) wetlands. Open water palustrine wetlands are estimated to comprise approximately 140 acres. Emergent vegetation wetlands and forested palustrine wetlands comprise approximately 240 and 900 acres, respectively. Unconsolidated bottom, aquatic bed, unconsolidated shore, and scrub-shrub palustrine wetlands comprise an additional 114 acres.

The number of wetlands within 1,250 ft of the pipeline centerline are compiled by milepost and county on Table 4G-1 of Appendix G. Wetland types and acreages are presented in Table 4G-2 of Appendix G.

4.2.3 Geologic Hazards

The geologic hazards (geohazards) discussed in this section are limited to earthquake/ seismic hazards, landslide/mass movement hazards, soil stress induced hazards (shrink/swell), subsidence associated with active faulting in the Gulf Coastal Plain, and erosion (scour) at stream crossings.

4.2.3.1 Earthquake/Seismic Hazards

For the purposes of this EA, earthquake/seismic hazards are defined as those seismic events that can potentially degrade the capabilities of the System or can cause sufficient damage to the System that may result in a release of petroleum products. A seismic event is a sudden motion or trembling of the Earth caused by the abrupt release of slowly accumulated strain in the Earth’s crust related to faulting or volcanism.

Texas has a generally well-documented history of earthquakes in recent times. The earliest recorded event occurred in north Texas on October 22, 1882. The event epicenter was probably in southeastern Oklahoma or southwestern Arkansas and was generally felt over a 375,000-square kilometer area. In Sherman, Texas, the event was recorded as a magnitude 4.8 (Richter Scale). More recently, an earthquake near Alpine, Texas, was recorded as a magnitude 5.6 on April 13, 1995. This is the largest earthquake in Texas since the August 16, 1931 seismic event near Valentine. That earthquake was recorded as a magnitude 6.0, damaging many buildings in the community. The great majority of seismic events in Texas are of a magnitude 3.0 or less. In fact, the El Paso, Texas area records earthquakes of magnitude 2 or less every few days. Nearly every year earthquakes large enough to be felt by citizens occur somewhere in Texas.

The primary source of seismicity data for Texas is the USGS with supporting data and references from The University of Texas – BEG (David et al., 1989). The most current seismicity modeling and seismic hazards mapping are available from the USGS (Baker, 1999).

The USGS has developed seismic hazard models for the conterminous United States based on a 2 percent (1 in 50), 5 percent (1 in 20), and 10 percent (1 in 10) probability of exceedance (PE) in a given 50-year period. PE is defined as the likelihood that a seismic event will occur in a 50-year period that will have an intensity greater than its associated peak ground acceleration (PGA). PGA is defined as the force related to the ground acceleration expressed as a percent of one standard Earth Gravity. The peak acceleration is the maximum acceleration experienced by a particle during the course of an earthquake motion.

The tables below summarize the seismic hazard zones crossed by the System. On each table, the modeled PGA (based on the associated PE) may be determined for any seismic hazard zone along the System route. PGA values for all values of PE along the System route range from 0.0 gravity (*g*) to 0.18*g* with the highest values occurring in the western areas of pipeline route. For example, in the area of western Culberson County (MP 598.19 – MP 612.10) along the System route, there is a 2 percent probability that the PGA will exceed 0.18*g* within any given 50-year period. In that same area, there is a 5 percent probability that the PGA will exceed 0.09*g* with any given 50-year period (MP 593.08 – MP 625.82 and MP 652.65 – MP 694.56), and a 10 percent probability that the PGA will exceed 0.05*g* in any given 50-year period.

PGA along the System 2 Percent PE in 50 years

Starting MP	Ending MP	PGA
0.00	165.92	.04
165.92	392.84	.02
392.84	431.40	.04
431.40	453.70	.06
453.70	487.07	.08
487.07	509.45	.10
509.45	565.53	.08
565.53	574.06	.10
574.06	583.59	.12
583.59	589.99	.14
589.99	598.19	.16
598.19	612.10	.18
612.10	620.66	.16
620.66	632.87	.14
632.87	656.06	.12
656.06	694.56	.14

PGA along the System 5 Percent PE in 50 years

Starting MP	Ending MP	PGA
0.00	183.56	.02
183.56	378.33	.01
378.33	421.81	.02
421.81	450.58	.03
450.58	479.14	.04
479.14	555.24	.05
555.24	570.24	.06
570.24	580.41	.07
580.41	593.08	.08
593.08	625.82	.09
625.82	652.65	.08
652.65	694.56	.09

PGA along the System 10 percent PE in 50 years

Starting MP	Ending MP	PGA
0.00	230.69	.01
230.69	360.87	0
360.87	430.02	.01
430.02	473.50	.02
473.50	544.56	.03
544.56	573.05	.04
573.05	624.62	.05
624.62	694.56	.06

The most significant seismic hazard area in Texas only has a PGA of approximately 0.03*g*. This site is located along the Rio Grande in western Jeff Davis County. Appreciable damage at this intensity is defined as damage to unreinforced masonry buildings. The likelihood of damage to the pipeline system from values of PGA ranging from 0 to 0.03 is considered negligible. Experience indicates that pipelines composed of welded ductile-steel piping are invulnerable to the type of ground shaking that accompanies an earthquake (Patterson, 1999). For comparison, the table below presents magnitudes of ground vibrations associated with common human-induced phenomena (IT Corp.-1, 2000).

Activity	Expected Ground Acceleration
Passing train	0.024*g*
Pile driving	0.049*g*
Newspaper press equipment	0.133*g*

In conclusion, the risk of damage to the System due to seismic activity is considered low.

4.2.3.2 Landslide/Mass Movement Hazards

Mass movements of earth materials, more commonly known as landslides, are defined as the moderately rapid to rapid (on the order of one foot per year or greater) downslope transport by means of gravitational body stresses. These landslides can result from a variety of causes, (earthquakes, excess ground water saturation, volcanism, and human activity). Whenever the topographic landforms become too unstable to maintain that form against the force of gravity, a mass movement or landslide is the result. Landslides can be catastrophically rapid or a slow creep taking years to show appreciable movement.

Types of mass movement that would be possible in Texas along the pipeline route are landslides in soil or rock masses or rock falls from overlying rock bluffs or cliffs. Naturally occurring mass movements in Texas are not common because steep topography and inherently weak material must both be present for mass movements to occur. Geomorphic erosional processes produce topography that is stable under natural conditions. In other words, natural processes will produce slopes that are stable under natural conditions. Steep topography is observed in the dissected Edwards Plateau and mountainous areas in Culberson and Huspeth counties. The geologic material in these regions (limestone, dolomite, and sandstone) are more resistant to erosion and produce steeper slopes. Pipeline hazards in these areas would be from rock falls in areas where the pipe is exposed below a steep ravine or rock bluff. Mitigation measures including routine inspection and covering the pipeline would protect against these rare occurrences.

East of the Edwards Plateau (eastern Travis County to the Galena Park Station), geology consists of soil materials which are generally not capable of sustaining steep slopes over time. Consequently, topography is relatively flat from eastern Travis County to the eastern terminus of the pipeline in the Galena Park Station. The pipeline route does not cross through areas that are susceptible to naturally occurring mass movement.

Mass movements in both areas are not uncommon in areas that have been altered by human activity such as road or railway cuts and embankments. Often these features are left with slopes steeper than the material can sustain over long-term natural processes, and eventually many of these slopes fail. Other activity, such as removal of material along the toe of a natural slope or adding significant amounts of fill to the crest of slopes, can also trigger mass movements.

Review of aerial photography along the pipeline route indicates that none of these man-made features occur within or near the pipeline ROW; therefore, the risk of mass movement due to human alteration is low. Future earth-moving activities near the pipeline that could pose a risk relative to future mass should be recognized during the routine pipeline inspections.

4.2.3.3 Aseismic Faulting/Subsidence Hazards

Aseismic faulting occurs in the Houston metropolitan area. It is considered aseismic because the movements are too small and too frequent to cause measurable earth tremors. The faulting is primarily due to consolidation of unconsolidated marine soils as water and petroleum products are pumped from these materials. As pore water pressures decrease in these formations due to pumping, the effective overburden stress increases resulting in consolidation. The result of the consolidation is seen at the ground surface as subsidence defined by movement across small faults.

Review of elevation data from 1906 to 1995 indicates total subsidence on the order of 7 ft in the area of the pipeline (IT Corp.-3, 2000). While this magnitude seems large, it occurs over a distance of more than 30 miles (IT Corp.-3, 2000). Movements of this magnitude over such a distance will not pose a threat to the integrity of the pipeline. There are several hundred petroleum product pipelines located in the subsidence area with no reported cases of failure due to subsidence. There are four active faults that cross the pipeline route in the Houston area.

4.2.3.4 Soil Stress Hazards

Soil stress hazards in the context of this document refer to stresses on the System due to volume changes of the surrounding soil.

The pipeline is located in materials from the Galena Park Station to Austin that exhibit volume changes due to changes in moisture content. The susceptibility of these soils to volume change is based on their chemical and physical structure. Clay-rich soils are the most susceptible to moisture-related volume change. These soils shrink when dried and swell when moistened. The movements are seasonal and depend on climatic conditions. During extended dry periods some of these soils in and just east of Austin can exhibit shrinkage cracks up to 4 to 6 inches wide and over 5 ft deep; whereas no cracking at all is observed in wetter times of the year.

It is these shrink/swell movements that can create stresses on the pipeline system and cause movement as the soil moves. These movements are small (inches), gradual, and regional; therefore, a few inches of movement may occur over several hundred feet of pipe. The pipe is capable of sustaining these types of movement.

Where pipes exit the ground at pump stations, there is a potential for *localized* differential movement between the pipe and the aboveground structures. Engineering controls are implemented which allow for flexibility at connections and reduce the risks of detrimental differential movement due to shrink/swell behavior of the soils.

4.2.3.5 Scour at Stream Crossings

One potential mode of pipeline failure is for the cover over the pipeline to erode during flood flows, exposing the pipeline to a lateral force. If this force were sufficiently large, the pipeline could be overstressed, resulting in a leak. The potential for this mode of failure to occur was evaluated as follows:

- The history of scour-related leaks and repairs for the pipeline was reviewed.
- Hydraulic calculations were performed to identify crossings with potentially excessive flood flow velocities.
- Current and historic aerial photographs were procured for each of the crossings of potential concern. These photographs were analyzed to identify crossings which showed evidence of channel instability.
- Site-specific geomorphic studies were performed for fourteen crossings. These studies provide estimated mitigation measures, if any, to address scour.

In general, the study progressed initially as a process of elimination whereby crossings that by their hydrologic or hydraulic characteristics had minimal potential for excessive scour and were eliminated from further study. Crossings for which conservative assumptions showed the potential for excessive scour were studied further.

Root Cause Study

The Root Cause Study (Longhorn, May 2000) individually addresses the causes of each of the known leaks and repairs for the history of the existing pipeline. The report states that "no record or evidence (has been found) that a river or stream crossing failure causing a spill had ever occurred on this pipeline." Three repairs were noted at two crossings. The Brazos River crossing was repaired in 1991 (riprap was placed around the pipe) and completely replaced in 1995 (using directional drilling under the streambed). The Colorado River crossing was repaired in 1993. This repair involved covering 80 ft of exposed pipe with sandbags. No scour-related leaks or repairs were noted in the report for any of the other pipeline stream crossings.

Hydraulic Evaluation of Selected Crossings

The maximum allowable velocity against an exposed pipe span was estimated. The pipe dimensions, material type, internal pressure, and transported material used in the calculation correspond to conservative Longhorn pipeline conditions. The source for choices of maximum allowable stresses is American Society of Mechanical Engineers (ASME) Code for Pressure Piping, B31.4. Details concerning the derivation of these maximum velocities are provided in a documented calculation (URS Dames & Moore, May 9, 2000). Maximum allowable velocities are summarized in Table 4-29. The pipe stresses used to define maximum velocity do not correspond to incipient failure of the pipe and include safety factors presented in the ASME Code. For instance, the allowable sustained load in the table corresponds to 54 percent of the elastic yield stress, which is in itself significantly less than the ultimate stress that potentially results in pipeline failure.

The crossings selected for evaluation include all stream crossings listed in Table 4-17, the environmentally vulnerable (Tier 2) crossings listed in Table 7-1 and the environmentally hypervulnerable (Tier 3) crossings listed in Table 7-2. This listing includes all the crossings of second stream order and higher and all crossings identified as environmentally vulnerable. The 10-year and 100-year flow velocities for each of these crossings was estimated using the best available (1:24,000) mapping, coupled with review of vegetation from project photography. These velocities are presented in Table 4-30. Details concerning the derivation of these velocities are provided in a summary of the Scour-related Study (Appendix 9D). Major crossings are not included in Table 4-30, as these crossings clearly warranted a more detailed site-specific geomorphic study.

Table 4-30 presents a comparison of estimated maximum flood flow velocities at each crossing versus maximum allowable flow velocities. It should be noted that this comparison, which is based upon a series of conservative assumptions, is performed for the purpose of identifying crossings needing further study and is not an identification of crossings where failure is likely. The documentation for this comparison is provided in the summary of Scour-related Study (Appendix 9E). These results show:

- East of MP 125, each evaluated crossing had flood velocities unlikely to overstress a pipeline, unless a long length of pipeline was exposed. There is no history of such exposure.

- West of MP 280, only two crossings had potentially unacceptable velocities. The smallest of the two watersheds corresponding to these crossings was 16 square miles. Crossings not evaluated in this reach have watersheds significantly smaller than 16 square miles.

- Between MP 125 and MP 280, 22 crossings had potentially unacceptable velocities, ranging from "marginally less" to "much greater than" the estimated allowable velocity.

Aerial Photograph Analysis

Current and historic aerial photographs were compared for 30 crossings. Of the 30 crossings, 24 were identified as having potentially excessive velocities in the hydraulic study and 6 are major river crossings (Brazos River, Colorado River, Onion Creek, Pedernales River, Llano River, and Pecos River). Comparisons were made for a distance of 0.5 miles upstream and 0.5 miles downstream of each crossing. The purpose of the comparison was to identify any significant changes in stream flow regime or visual evidence of scour which would warrant a site-specific geomorphic study.

These analyses did not reveal potential significant instabilities in the immediate area of these pipeline crossings. These analyses indicated that at three of the crossings, JD Creek, Long Branch, and a Sandy Creek tributary at MP 236.7, there was a potential area of instability within 0.5 miles. Given the importance of the Barton Creek crossing, this crossing was also identified for further study.

Evaluation of Rock Crossings

The estimation of velocities at pipeline crossings indicated that the potential flood velocities at selected crossings confined within limestone beds and banks to be extremely high, between 18 and 30 ft per second for the 100-year flood. The exposure of less than 50 ft of suspended pipe to these velocities could potentially lead to excessive pipeline stresses, and ultimately, leakage.

WES prepared a report addressing the construction of the pipeline crossings within the rock bed region (approximately MP 181 to MP 277). This report included a review of available construction details for crossings within this region, and a description of nine crossings visited in June 2000. In summary, the report stated:

- Construction specifications exist for selected major river crossings only: the Llano River and Pedernales River. At these crossings, a trench was to be blasted or cut into the rock bed such that the top of the pipe will be a minimum of 4 inches below the lowest point of the riverbed. The pipe was to be backfilled with small rock and earth within 6 inches of the surface of the riverbed and the ditch was then sealed with 6 inches of concrete made smooth and flush with the riverbed. These crossings were visited as part of the Level 1 geomorphic analysis.

- The replacement of the James River crossing included the installation of river weights at 50 to 70 ft spacings along the pipeline;

- The nine additional crossings visited in June 2000 included several crossings with extremely high potential flood velocities (Barton Creek, Cottonwood Creek, Crabapple Creek, Buffalo Creek, and Threadgill Creek). These crossings were all found to be placed within a trench in the rock bed such that the pipeline rests below the surface of the streambed. Cover for the pipeline generally consisted of native erodible material. One of the crossings showed signs of recent work to replace cover (Threadgill Creek) and one (Cottonwood Creek) showed a need to have cover re-installed.

- Several of the crossings with rock beds were scheduled previously for mitigation to add/replace cover. These include Flat Creek and Fitzhugh Creek.

Given that the cover for the pipeline within the rock bed crossings is potentially erodible, there is the potential for this cover to be eroded during floods. Without cover, the pipeline could float up into the flood flow, exposing suspended pipe to flood velocity-induced stresses. A calculation was performed to estimate maximum pipeline lengths exposed for varying flood velocities. This calculation estimated the following:

- The six-inch concrete covering placed over the pipeline for the major river crossings is sufficient to prevent uplift during flooding;

- For 50 ft of exposed trench, there is essentially no risk of the pipeline being uplifted into flow for the range of velocities estimated. For 100 ft of exposed trench, there is essentially no risk of the pipeline being uplifted into flow for velocities under 22 ft per second. For over 150 ft of exposed trench, significant lengths of pipeline could be uplifted into flow for velocities over 12 ft per second.

Given the above, five crossings have widths large enough and velocities high enough to warrant prevention of uplift into flood flow. These crossings are Flat Creek, Cottonwood Creek, Crabapple Creek, Squaw Creek, and Threadgill Creek.

Site-Specific Study/Mitigation Design

Fifteen crossings were selected for detailed, site-specific analyses. These include the seven major river crossings (Brazos River, Colorado River, Onion Creek, Pedernales River, Llano River, James River, and Pecos River), the four crossings identified in the aerial photograph analysis (JD Creek, Long Branch, Barton Creek, and Sandy Creek at MP 236.7), all hypervulnerable (Tier 3) crossings with alluvial (as opposed to rock) streambeds (Marble Creek, Boggy Creek, Slaughter Creek), and all vulnerable (Tier 2) crossings identified as potentially having excessive flood flow velocities (Alum Creek). The Rabbs Creek and Cedar Creek crossings, which were known by earlier observation to be unstable, were also studied as part of the remedial design process.

These studies were performed in accordance with the procedures for Level I study (Geomorphic Analyses) described in "Stream Stability at Highway Structures" (DOT, 1991). For the major river crossings, selected tasks from Level 2 (Basic Engineering Analyses) were also performed.

The basic conclusions to be derived from thee studies are:

- The crossings at Rabbs Creek and Cedar Creek tributary are noted as unstable;
- The crossing at Sandy Creek tributary (MP 236.7) was noted to require additional cover;
- The Colorado River crossing is high risk, and has the potential for flood-induced erosion at the edges of the riprap blanket. Some instability is noted in the bankslopes;
- The crossing at Barton Creek and Onion Creek are marginally unstable laterally and vertically, and have high potential flood velocities; and
- The crossings at Pin Oak Creek and Cummins Creek are marginally unstable laterally and vertically, and have relatively low potential flood velocities.

The mitigations recommended to address these Level 1 and 2 study conclusions and the issue of potential uplift at the five rock crossings are summarized in Appendix 9E.

4.2.4 Climate and Air Quality

4.2.4.1 Climate

The proximity to the Gulf of Mexico in southeast Texas yields a persistent southerly and southeasterly flow of warm tropical maritime air into Texas from around the westward extension of the Bermuda High. Combined with adequate rainfall, this produces a humid subtropical climate with hot summers across the eastern third of the state. The prevailing wind direction in southeast Texas, as measured at the Houston Bush Intercontinental Airport, is primarily from the south southeast, with some variance to the east southeast and from the south. In January, the prevailing wind direction is from the north northwest. Average January daily low temperatures for Houston are 41 degrees Fahrenheit (ºF); average July highs are 94ºF. Average annual rainfall is 45 inches.

The Gulf moisture supply gradually decreases westward and is cut off more frequently during the colder months by intrusions of drier polar air from the north and west. As a result, most of central Texas has a subtropical climate with dry winters and humid summers. This region is semi-arid. The prevailing wind direction is primarily from the south, with some variance to the south southeast in the spring. Average January daily low temperatures for Austin are 39ºF; average July highs are 95ºF. Average annual rainfall is 32 inches.

As the distance from the Gulf increases westward, the summer moisture supply continues to decrease gradually, producing a subtropical steppe climate across a broad section of west Texas, including the Pecos Valley. In this area, rainfall is inadequate for agriculture without supplemental irrigation. The prevailing wind direction, as measured at San Angelo's Mathis Field, is primarily from the south, with some variance from the southwest in the winter. Average January daily low temperatures for San Angelo are 39ºF; average July highs are 95ºF. Average annual rainfall is 18 inches.

Except for "islands" of cool temperature, mountain type climates at higher elevations west of the Pecos River are mostly arid subtropical. Rainfall is inadequate for other than desert or semi-desert types of vegetation. The mountain climates in the Trans-Pecos are cooler throughout the year than those of the adjacent lowlands. Temperatures decrease with altitude and average about 1 degree lower for each 300 ft of increased elevation. The prevailing wind direction, as measured at the El Paso International Airport, is from the north from October through February. In the spring, the prevailing wind direction is from the west southwest. During the summer and early fall, the prevailing wind direction is from the south, with some variance from the south southeast. Average January daily low temperatures for El Paso are 30ºF; average July highs are 95ºF. Average annual rainfall is 7.8 inches.

4.2.4.2 Air Quality

The EPA has set national ambient air quality standards (NAAQS) for six commonly occurring or "criteria" pollutants. These include: ozone (O_3), particulate matter 2.5 microns or less ($PM_{2.5}$), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), carbon monoxide (CO), and lead (Pb). Ozone is a secondary pollutant formed by a series of complex reactions in the atmosphere involving oxides of nitrogen (NO_x) and volatile organic compounds in the presence of short-wave solar radiation. $PM_{2.5}$ is all finely-divided solid or liquid material (e.g., smoke, dust, mist) emitted to the atmosphere other than uncombined water. NO_2 is an indirect product of combustion process. At normal combustion temperatures, atmospheric nitrogen disassociates and combines with excess oxygen to form NO_x. SO_2 is a direct product of the combustion of sulfur which is a natural component of oil, gas, and coal. Thus, SO_2 emissions occur as a byproduct of combustion of those fossil fuels and can also occur during petroleum refining. NO_2 and SO_2 contribute to acid rain. CO is a byproduct of combustion processes. CO is an asphyxiate and causes lightheadedness. Lead emissions are primarily the result of lead additives in automotive fuel. Lead is a toxic substance when inhaled.

NAAQS Attainment: Southeast Texas

Southeast Texas contains two ozone non-attainment regions. One ozone non-attainment region is the Beaumont/Port Arthur area, comprised of Hardin, Jefferson, and Orange counties. This area is east of the pipeline's origin in Houston and based on the distance from the pipeline and prevalence of the petro-chemical industry in that area, the pipeline does not directly impact the air quality of the Beaumont/Port Arthur region. The other ozone non-attainment area in southeast Texas is the Houston/Galveston area, comprised of Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller counties. This area is classified as a severe ozone non-attainment area. Severe ozone non-attainment indicates that the State Implementation Plan (SIP), a plan to bring an area back into attainment status, will take 15 to 17 years to obtain attainment status ambient levels of ozone. All other criteria pollutants in southeast Texas are currently in attainment status.

NAAQS Attainment: Central Texas

Central Texas is also currently in attainment status for all criteria pollutants. However, both the Austin and San Antonio areas have reported exceedances of ambient ozone levels. The exceedances have not been enough to re-classify either the Austin area or the San Antonio area to non-attainment, but ozone levels are currently a concern in both areas.

NAAQS Attainment: West Texas

West Texas is currently in attainment status for all criteria pollutants, primarily because this region has relatively little industrial development and has a relatively low population density. Based on the low population density and lack of industrial activity, air quality does not appear to be a concern in this region.

NAAQS Attainment: El Paso Area

Far west Texas includes non-attainment zones in El Paso County. El Paso County is non-attainment for several criteria pollutants. The county has portions that are serious non-attainment for ozone, moderate non-attainment for $PM_{2.5}$, and moderate non-attainment for CO. Serious non-attainment for ozone designates that the SIP will take 15 to 17 years for a region to obtain attainment status.

4.3 ECOLOGICAL RESOURCES

Ecological resources pertain to biomes (communities of living organisms of a single major ecological region), flora and fauna, and threatened and endangered species that could be affected by pipeline operations, maintenance, or an accidental release of product. The following sections describe natural regions, vegetation, aquatic biology, and terrestrial biology. The information presented was obtained primarily from US Fish and Wildlife Service (FWS), TPWD, and LCRA.

The EA lists all species of concern that are known to be within counties that are crossed by the pipeline. The list provided as Table 4H-1 includes approximately 215 species of concern. Although state listed threatened or endangered species are protected under state regulations, discussions with TPWD personnel during initial project phases indicated that a matrix listing (as presented in Table 4H-1) would meet project needs. Species of concern that were evaluated in detail were limited to those that have been listed by the FWS as either threatened or endangered as presented in the Phase I BO and Phase II Concurrence Letter.

4.3.1 Terrestrial Resources

Natural Regions Traversed by the Longhorn Pipeline

The TPWD lists 11 natural regions within the state (TPWD, 1978), of which six are crossed by the existing Longhorn pipeline. Those regions crossed, listed from east to west, are: Gulf Coast Prairies and Marshes, Blackland Prairies, Oak Woodlands and Prairies, Edwards Plateau, Llano Uplift, and the Trans-Pecos (See Figure 4-15). The pipeline also crosses the "Lost Pines" subregion of the Oak Woodlands and Prairie natural region. These regions are summarized in the following text.

Gulf Coast Prairies and Marshes

Harris and Waller counties are located at the northern edge of the Gulf Coast Prairies and Marshes natural region that extends inland approximately 50 miles. The area exhibits little topographic relief and is comprised of sluggish rivers, creeks, bayous, swamps, and freshwater marshes. Climax vegetation in the area is principally grassland (tall-grass prairie) and post oak savannah; however, much of the area has been invaded by trees and brush such as mesquite (*Prosopis glandulosa*), live oak (*Quercus virginiana*), prickly pear (*Opuntia* spp.), and several species of acacias. Dominant grasses include big bluestem (*Andropogon gerardi*), eastern grama (*Tripsacum dactyloides*), gulf muhly (*Muhlenbergia capillaris*), and several species of panicum. Portions of the natural region crossed by the pipeline extend from MP 0.0 to MP 71.2, as shown on Figure 4-15.

Blackland Prairies

The Blackland Prairies natural region consists of two relatively narrow zones separated with zones of oak woodlands and prairies. The eastern portion of the region extends from the Gulf Coast Prairies and Marshes at MP 71.2; the western extent of the Blackland Prairies region lies along the eastern margin of the Balcones Escarpment and the Edwards Plateau natural region (MP 167.2). A relatively narrow band of Oak Woodlands and Prairies natural region crosses the Blackland Prairies region from MP 105.8 to MP 148.9. Regional topography of the Blackland Prairies region is characterized as gently rolling prairies dissected by well-defined streams and drainages. Tall-grass communities dominate the native vegetation within the region, and post oak (*Quercus stellata*) and blackjack oaks (*Quercus marilandica*) are common. Important grass species include hairy grama (*Bouteloua hirsuta*) and dropseed (*Sporobolus* spp.).

Oak Woodlands and Prairies

The Oak Woodlands and Prairies natural region (also known as the Cross Timbers and Prairies Vegetational Area) supports a wide variety of flora and fauna species. The region consists of woodlands dominated by oaks and hickories, interspersed with a mosaic of prairie. Dominant woody species include post oak and blackjack oak; however, cedar elm (*Ulmus craassifolia*) and pecan (*Carya illinoinensis*) are common along streams and rivers. Common grasses include little bluestem (*Schizachrium scoparium*), big bluestem (*Andropogon gerardi*), Indian grass (*Sorghastrum avenaceum*), switchgrass (*Panicum virgatum*), and Canada wild-rye (*Elymus canadensis*). Parts of the region were historically used for grazing, which has contributed to the development of thickets of yaupon (*Ilex vomitoria*), and brumelia, and extensive areas that have become dominated by mesquite. Approximately 43 linear miles of the System crosses the region, from MP 105.8 to MP 148.9.

The Lost Pines subregion, which lies within the Oak Woodlands and Prairies natural region, is comprised of mature loblolly pines (*Pinus taeda*) within a unique sandy soil environment. The existing pipeline crosses the subregion in central Bastrop County from MP

127.5 to MP 128.8. The Lost Pines subregion provides unique habitat for numerous rare endemic species, and the Colorado River is important to the Bald Eagle, Osprey, and numerous other avian species. Although such species as the Pine Warbler (*Dendroica pinus*), Pine Siskin (*Carduelis pinus*), Pileated Woodpecker (*Dryocopus pileatus*), Black-bellied Whistling Duck (*Dendrocygna autumnalis*), Green Kingfisher (*Chloroceryle americana*), and Osprey *(Pandion haliaetus*) may be present in Bastrop County, they are not listed on the TPWD Annotated County List of Rare Species for the county.

Edwards Plateau

The Edwards Plateau natural region extends from the Balcones Escarpment in Austin through west central Texas to the Stockton Plateau. Streams and rivers within the region typically are fast flowing and clear or nearly clear. The region is comprised of cedar brakes with dense growths of juniper, scrub oaks, and mesquite. Dominant grasses of the Plateau include switchgrass and several species of bluestems and gramas. Rocky soils of the area typically support a tall-grass understory and a brush overstory that is generally comprised of oaks, junipers, and mesquite. Streams throughout the area are often well-drained ephemeral drainages that provide habitat for a variety of plant and animal species not common in more upland areas of the Plateau. Approximately 278.9 linear miles of the pipeline cross the Plateau, including approximately 66.3 miles that cross the Llano Uplift, which is a subregion of the Plateau.

Llano Uplift

The Llano Uplift is a subregion of the Edwards Plateau that is of igneous geologic origin. The area is dominated by oak-hickory woodlands, mesquite savanna, and stands of oak and juniper that are interspersed among homogeneous or nearly homogeneous oak communities. Dominant species within the subregion are mixtures of those within the Edwards Plateau natural region. The area also supports a wide variety of wildflower species and habitat for deer, small mammals, and a wide variety of avian species that are similar to the Edwards Plateau natural region. The Uplift is crossed by four segments of Longhorn pipeline, from MP 203.1 to MP 224.1, MP 226.5 to MP 243.6, MP 248.2 to MP 272.4, and MP 275.9 to MP 279.9.

Trans-Pecos

The Trans-Pecos natural region is comprised of highly diverse habitats and vegetation communities and includes a portion of the Chihuahua Desert. As a result of poor drainage, lowland area soils are often characterized by accumulations of alkali. Rangelands are typically comprised of stony hills, clay flats, sands, salty-saline soils, gypsum flats, stony mountains, gravelly outwashes, and badlands. Vegetation within the region includes desert scrub comprised of creosote (*Larrea tridentata)* and tarbrush (*Flourensia cernua)*, grama grasslands, and yucca and juniper savannas. Piñon pine (*Pinus cambroides*) and oak forests and a limited amount of ponderosa pine (*Pinus ponderosa*) forests are present at elevations above 5,000-ft mean sea level. The System crosses the Trans-Pecos region west of MP 446.1 to the El Paso Terminal. The Odessa Lateral also is within the Trans-Pecos natural region.

4.3.1.1 Terrestrial Fauna and Flora

Longhorn pipeline traverses a variety of wildlife habitats and passes through the distributional ranges of many species. As the route crosses the state from east to west, species composition is influenced by the vegetation present, water availability, and to a large degree, by land ownership and land management practices.

White-tailed deer (*Odocoileus virginianus*) is an important big game animal in areas along the pipeline and throughout other parts of the state. Deer population levels in 1991 were estimated at more than three million (TPWD, 1994) with herd sizes exceeding estimated carrying capacities in some areas. Other big game animals along the pipeline include javelina (*Pecari tajacu)*, mule deer (*Odocoileus hemionus)*, and pronghorn antelope (*Antilocapra americana)*. Javelina populations are scattered, but are highest in the Trans-Pecos natural region. Mule deer and pronghorn antelope are found primarily in the Trans-Pecos but also inhabit areas of isolated habitat in the Edwards Plateau natural region.

In addition to the native big game species, many landowners along the western portions of the route augment their income through commercial hunting of imported or exotic game species. More than 80 percent of the exotic species that are raised for hunting comprise six species. The axis deer (*Axis axis*) is an abundant exotic ungulate in Texas and are free-ranging in southern Texas; however, the majority are in captivity in ranches spread over 67 counties. The second most abundant exotic species is the blackbuck antelope (*Antilopa cervicapra*), with the highest concentration in the Edwards Plateau region. The nilgai (*Boselaphus tragocamelus*) is an abundant free-ranging exotic ungulate in Texas. The fifth-ranked Barbary sheep (*Ammotragus lervia*) was introduced in Palo Duro Canyon and has since spread to the Edwards Plateau, Trans-Pecos, Oak Woodlands, and other parts of Texas. Sika deer (*Cervus hippon*) is widely distributed in central and south Texas, including counties along the Longhorn pipeline (Traweek, 1985).

A variety of nongame mammals, birds, reptiles, and amphibians are supported by the varied habitats that exist along the pipeline route. Depending on the type of ecosystem, dominant mammals may include raccoon (*Procyon lotor)*, coyote (*Canis latrans)*, bobcat (*Lynx rufus)*, badger (*Taxidea taxus)*, and gray fox (*Urocyon cinereoargenteus).* These species, along with the armadillo (*Dasypus novemcinctus)*, opossum (*Didelphis virginiana)*, blacktailed jackrabbit (*Lepus californicus)*, and striped skunk (*Mephitis mephitis)* comprise the most common mammals found in proximity to the pipeline (TPWD, 1994).

Over 620 species of birds are known to occur in Texas (TPWD, 1994), many of which are migratory. Most permanent resident species have some economic or recreational value. Raptors provide a level of rodent control, and vultures are important as common scavengers. Species of gamebirds include dove (*Columba* spp.), quail (*Callipepla* spp.), turkey (*Meleagris gallopavo*), ducks, and geese. Songbirds, such as sparrows, finches, and warblers, serve as insectivores, as well as being important species for recreational bird watchers.

Amphibian and reptilian species present along the Longhorn pipeline route are diverse. Amphibians such as the Texas Toad (*Bufo speciosus*), Red-spotted Toad (*Bufo punctatus*), and Barred Tiger Salamander (*Ambystoma tigrinum mavortium*) are restricted to rivers, lakes, and springs along the route and increase in frequency of occurrence from west to east. Reptiles, especially snakes such as the Trans-Pecos Rat Snake (*Bogertophis subocularis*), Western Hooknose Snake (*Gyalopion canum*), and Striped Whipsnake (*Masticophis taeniatus*) and lizards such as the Texas Banded Gecko (*Coleonyx brevis*), Longnose Leopard Lizard *(Gambelia wislizenii wislizenii*), and Trans-Pecos Striped Whiptail (*Cnemidophorus inornatus heptagrammus*), are most common in the drier habitat of the western portion of the state, the Trans-Pecos vegetational region in particular. Many snake species occur in greater numbers in the central and eastern counties where water is more abundant.

4.3.1.2 Terrestrial Fauna and Flora along the Austin Re-route Alternative

The Austin Re-route Alternative crosses the Blackland Prairies and Edwards Plateau natural regions, which are described in Section 4.3.1. Blackland Prairies would be crossed from the vicinity of Pilot Knob to Buda; Edwards Plateau would be crossed for the remainder of the re-route west of Buda. Dominant grasses and forbs are likely to include mixtures of native and introduced species. Woody species in the area include hackberry and elm that are largely along fence lines; however, oaks (post oak and blackjack oak) are present in some relatively isolated areas.

Vegetation resources that are typical of the Edwards Plateau natural region extend from the vicinity of Buda to the tie-in at the existing Longhorn pipeline, west of Austin (MP 173). Natural vegetative communities along portions of the route have been modified by landowners through removal of junipers and other less desirable species. Areas that have been maintained as a mixture of oaks and juniper support a diversity of avian and mammalian species.

Wildlife in the Blackland Prairies and Edwards Plateau natural regions differ as a result of habitat characteristics. Mature and young trees, shrubs, and underbrush within the Edwards Plateau natural region provide habitat for white-tailed deer and many species of passerine birds that are less plentiful within the Blackland Prairie region. The Edwards Plateau region also provides habitat for cave-dwelling invertebrates and bats that is not available in the Blackland Prairies. Mammalian species that are present within both natural areas include skunk, raccoon, armadillo, and opossum; however, such species are largely restricted to areas with relatively dense vegetation and woodlands that are prevalent along the Balcones Escarpment and the Edwards Plateau. Locations of natural regions are shown in Figure 4-5.

4.3.1.3 Terrestrial Fauna and Flora along the El Paso Laterals

Biological resources along the proposed Fort Bliss alignment have been modified as a result of the construction of an electric transmission line, a fence along the Fort Bliss property boundary, and the construction of Joe Battle Boulevard. Other factors, such as periodic off-road vehicle activity along portions of the alignment, also have a continuing effect on resources in the area. Native vegetation along the Montana Avenue Route Alternative has been significantly changed and, in most cases, eliminated as a result of road construction and vehicular activity. The El Paso Laterals (consisting of the proposed Fort Bliss alignment and the Montana Avenue Route Alternative) are in the Trans-Pecos natural region, which is characterized as desert environment.

The Western Burrowing Owl (*Athene cunicularia*) is a species of concern that has been reported from Fort Bliss property (3D/International Environmental Group, 1997). The species is known to occur in association with prairie dog towns and similar conditions where it inhabits existing borrows. However, no individuals or suitable habitat were observed during the April 1999 field reconnaissance.

Proposed Fort Bliss Alignment

Species observed during the April 1999 field reconnaissance of the proposed Fort Bliss alignment indicate that dominant plant species that would be impacted by pipeline construction are limited to mesquite coppice dunes. The dunes, which have been formed as a result of wind and water erosion, are widely distributed throughout the area with intervening areas of non-vegetated sand and gravel.

Native species to the area include a variety of passerine birds, *falconiformes* (hawks), *gilliformes* (quail), *columbiformes* (doves and pigeons), lizards, and snakes. Lack of water precludes the presence of large numbers of mammals, although coyote and jackrabbits are likely to be present. Those species noted during the field reconnaissance were limited to black-throated sparrow (*Amphispiza bilineata)* which is common to desert scrub habitat.

Montana Avenue Route Alternative

The Montana Avenue Route Alternative parallels a major highway (US 180) from the El Paso Terminal to an injection point immediately west of El Paso International Airport. Land uses along the alignment (refer to Section 4.1.5.2) range from relatively undeveloped areas from the terminal to the city limits to commercial and residential areas within the city limits. Consequently, native vegetation along the alignment has been eliminated due to a combination of road construction and land development.

4.3.2 Aquatic Resources

The Longhorn pipeline crosses approximately 288 streamlines (based on USGS 1:100,000-scale hydrography). Of those crossings, ten were considered to be ecologically important and were selected because they reflect the above-referenced natural regions. All ten water bodies support fish species indigenous to Texas, and each major game fish species within the state is represented in at least one of the ten rivers. Each significant surface water body is described below, along with a wetland description obtained from FWS National Wetland Inventory maps (various dates). The ten surface water features that are crossed by the Longhorn pipeline are shown in Figure 4-15. Locations of these crossings (county and MP locations) are listed in the following table.

Ecologically Important River Crossings and Associated Natural Region

Surface Water Feature	County	Approximate MP	Associated Natural Region
Greens Bayou	Harris	3.2 and 6.0	Gulf Prairies and Marsh
White Oak Bayou	Harris	32.0	Gulf Prairies and Marsh
Cypress Creek	Harris	47.1	Gulf Prairies and Marsh
Brazos River	Austin/Waller	64.0	Blackland Prairies
Colorado River	Bastrop	134.5	Oak Woodlands and Prairies
Onion Creek	Travis	164.0	Oak Woodlands and Prairies
Barton Creek	Travis	180.9	Edwards Plateau
Pedernales River	Blanco	198.8	Edwards Plateau
Llano River	Kimble	276.5	Llano Uplift
Upper Pecos River	Ward/Reeves	525.6	Trans-Pecos

Greens Bayou, White Oak Bayou, and Cypress Creek

Longhorn pipeline crosses Greens Bayou at two locations (MP 3.2 and MP 6.0). White Oak Bayou and Cypress Creek are crossed at MP 32.0 and MP 47.1, respectively. Greens Bayou and White Oak Bayou are within an urban setting, and both have been channelized for flood control. Both bayous have sloping banks that are maintained in native grasses to aid in bank stabilization. The water is slow-moving over a bottom substrate partially comprised of gravel and silt. Longhorn pipeline crosses Cypress Creek in rural Harris County. The creek is partially channelized due to the installation of flood control measures; however, a large portion of the waterway has not been modified. Vegetation along the creek margin is comprised of bald cypress (*Taxodium distichum),* hackberry (*Celtis occidentalis*), and willow (*Salix* spp).

Greens Bayou and White Oak Bayou are classified by the FWS as palustrine with scrub-shrub vegetation (Moring, 1999). Cypress Creek, at the pipeline crossing, is classified by the FWS as palustrine. Wetland classification definitions are provided in the Definition of Terms.

Brazos River

Longhorn pipeline crosses the Brazos River at the boundary between Waller and Austin counties at MP 64.0. The river is typical of others in the Blackland Prairies natural region and is slow-moving, meandering, and turbid. Mature trees line the banks of the Brazos River, and many areas are popular for recreational fishing (Simmons, In Press).

Colorado River

The Colorado River is crossed at MP 134.5 and is characterized as wide and slow-moving, flowing over a substrate of silt. River banks are lined with willow, cottonwood, elm, and sycamore which aid in bank stability and provide cover for fish. Large areas within the river floodplain are under cultivation and used for pecan production. The Longhorn pipeline crossing is classified by the FWS as open water and forested palustrine (Bonn, 1980; Hubbs, 1982).

Onion Creek

Onion Creek is crossed at MP 164.0, within the Austin city limits. The creek flows from the Edwards Plateau to the Blackland Prairies natural region, and the location crossed by the pipeline is approximately 3 linear miles from the transition of the two natural areas. Locations within the plateau are characteristically deeply incised with steep river banks that are cut to Cretaceous limestone; the channel within the Blackland Prairies region (including the pipeline crossing location) is broader with less defined slopes. Dominant species associated with the river include sycamore (*Platanus occidentalis)*, cottonwood (*Populus deltoides)*, American elm (*Ulmus americana)*, cedar elm, and pecan trees. National Wetlands Inventory data for the Onion Creek crossing indicate that area wetlands are classified as emergent palustrine, forested palustrine, and intermittent riverine.

Barton Creek

The pipeline crosses Barton Creek in Travis County at MP 180.9. Barton Creek is on the Edwards Plateau, is spring-fed, and has limestone banks and substrate. The creek flows between multiple pools and riffles throughout its length, and vegetation composition along Barton Creek is characteristic of the Edwards Plateau natural region. Dominant species along the creek margin include bald cypress, sycamore, cottonwood, American elm, cedar elm, and pecan trees. The FWS classifies this Longhorn pipeline crossing location as palustrine, scrub-shrub palustrine with an unconsolidated bottom.

Pedernales River

Longhorn pipeline crosses the Pedernales River in Blanco County at MP 198.8. The river is shallow throughout much of its length and generally flows clear along rocky banks that are lined with bald cypress and cottonwood trees. River flows can increase dramatically after a heavy rain, and flooding of riverine areas is common. The Pedernales River crossing location is classified by the FWS as forested palustrine (Simmons, In Press).

Llano River

The Llano River is crossed in Kimble County at MP 276.5. The spring-fed river flows over limestone and gravel substrate, producing many small riffles. Limestone banks vary in slope. Wetlands at the crossing are classified by the FWS as scrub-shrub palustrine and lower perennial riverine (Simmons, In Press).

Upper Pecos River

The western-most ecologically significant surface water body crossed by the Longhorn pipeline is the Upper Pecos River. Longhorn pipeline crosses the river at the boundary between Ward and Reeves counties at MP 525.6. The river is sluggish, flowing through a narrow and shallow channel. The water is slightly saline due to the soils in the area and saline ground water seeps and springs that drain to the river. The salinity creates a unique habitat for some fish species. The FWS classifies the area of the river crossed by the Longhorn pipeline as unconsolidated shore, palustrine, and lower perennial riverine (Millan, 1999).

4.3.2.1 Austin Re-route Aquatic Fauna and Flora Along the Austin Re-route Alternative

Three significant surface water features would be crossed by the Austin Re-route Alternative. These include Big Bear Creek, Little Bear Creek, and Onion Creek. Riparian habitat associated with the creeks include mature stands of elm, ash, and hackberry trees, as well as riverine vegetation of dense native grasses and forbs. Although field surveys have not been performed to determine the biological composition of area streams, it is likely that various species of fish, amphibians, and reptiles would be present.

Other species that may be present along the Austin Re-route include karst-related invertebrates. Texas rivers and lakes support a wide variety of fish species. Most riverbanks in Texas are heavily vegetated, which provide shade and suitable habitat for fish, and many Texas rivers are used for recreational fishing. Common fish species are listed in Table 4-33.

4.3.2.2 Aquatic Fauna and Flora Along the El Paso Laterals

No areas of wetlands or permanent surface water features are located along either the proposed Fort Bliss alignment or the Montana Avenue Route Alternative.

4.3.3 Threatened and Endangered Species

A comprehensive list of potentially affected federally listed threatened or endangered species and species that are candidates for listing as either threatened or endangered (TPWD, 1998; TPWD, 1999a) was established using two criteria: the presence of coinciding habitat within or in close proximity to the pipeline ROW and habitat that potentially could be affected by a release of product.

Species of concern that could be affected were compiled from listings provided by TPWD. Federally listed and state listed threatened or endangered species that are known to occur in Bastrop County and may be affected by a release of product are listed in Table 4-31, and habitat requirements are provided in Table 4-32. As reported in Table 4-31, TPWD records indicate that three federally listed species are known to occur in the county. A total of 16 species of concern that are known to occur in the county are listed in Appendix Table 4H-1.

Potential impacts to federally listed threatened or endangered species are addressed in Phase I and Phase II Biological Assessments (BA) that were prepared for the project. The BAs, which were prepared for consultation with the FWS, identify 9 federally listed threatened or endangered species that potentially could be impacted during routine maintenance or construction activities or from a release of product from the System. The Phase I BA and Biological Opinion (BO) (which address ROW maintenance operations) and the Phase II BA and FWS Concurrence Letter (which address operation long-term maintenance, and emergency response issues) are included in Appendix 4E.

Table 4-31 lists the species included in the analysis by common and scientific name, status, counties of occurrence, and region of occurrence. Table 4-32 provides a description of habitat requirements. A comprehensive listing of all federally listed and state listed species that are known to occur within counties crossed by Longhorn pipeline are listed in Appendix 4H.

4.3.3.1 Protected Terrestrial Species

The Phase I and Phase II BAs indicate that 9 federally listed threatened or endangered species potentially could be affected by maintenance or construction activities or as a result of a release of product from the System. Those species include five avian species, an amphibian species, and three plant species. Species that could be affected and are listed in the Phase I and Phase II BAs are described in Tables 4-31 and 4-32. Detailed information about the species is provided in Appendix 4H.

4.3.3.2 Protected Aquatic Species

Information provided in the Phase I and Phase II BAs indicates that the Barton Springs Salamander is the only federally listed threatened or endangered aquatic species that could be impacted due to a release of product (see Appendix 4E).

4.3.3.3 Austin Re-route Alternative

Threatened and endangered species that would be potentially affected by the construction, operation, and maintenance activities of the Austin Re-route include the Golden-cheeked Warbler (*Dendroica chrysoparia*) and the Black-capped Vireo (*Vireo atricapillus*) which are both listed by the FWS and TPWD as endangered. Habitat requirements for the Golden-cheeked Warbler include mature ashe juniper (*Juniperus ashei*) that is intermixed with oaks and other hardwoods. The Black-capped Vireo requires dense thickets of persimmon, sumac, and similar species, which may be present along some locations of the Austin Re-route Alternative.

4.3.3.4 Threatened and Endangered Species Along the El Paso Laterals

A review of TPWD Biological Database records indicate that there are no reports of threatened or endangered species along the proposed Fort Bliss alignment or the Montana Avenue Route Alternative. Sneed pincushion cactus (*Coryphantha sneedii* var. *sneedii*) (federally listed as endangered) has been reported from El Paso County. However, the species has a limited distribution and is associated with limestone ledges of the Chihuahuan Desert that are not present within the project area. The Southwestern Willow Flycatcher (*Empidonax traillii extimus*) (listed as endangered) and the Mexican Spotted Owl (*Strix occidentalis*) (listed as threatened) also are reported from El Paso County. However, habitat requirements for the flycatcher are associated with desert willow (*Chilopsis linearis*), tamarisk (salt bush), and baccharis which are not present in this portion of the route. Similarly, the Mexican Spotted Owl is indigenous to mountains and canyons containing dense forests with closed canopy that are not present in the area.

4.4 CULTURAL RESOURCES

4.4.1 Existing Longhorn Pipeline

Cultural resources along the existing Longhorn pipeline from Houston to Crane were previously disturbed during construction in the 1950s and periodic ROW maintenance. Resources present along the alignment from Crane to El Paso and Crane to Odessa were disturbed (following appropriate cultural resources investigations and clearance from the Texas Historical Commission) during the 1990s. Consequently, previously reported archaeological resources along the alignment were not considered in the compilation of baseline information.

The Texas Historical Commission database was accessed to determine if the *National Register of Historic Places* (National Register) is within 1,250 ft from the existing Longhorn pipeline centerline. Although some National Register sites in Bastrop County did appear on the database, none of the sites listed were within the 1,250 ft of either side of the pipeline (Julian, 1999).

Historic resources that potentially could be affected, as a result of an accidental release of product, are likely to be limited to several cemeteries located along the existing pipeline ROW. Other important historic resources may be associated with rural towns and town sites that are scattered along the alignment.

A review of available data indicated that at least 16 cemeteries, numerous unnamed graves, and several churches are within 1,250 ft of the pipeline. No known National Register eligible sites were identified within 1,250 ft of the existing corridor.

The EPA and DOT in consultation with the Texas State Historic Preservation Officer (SHPO), Tribal Historic Preservation Officer(s) (THPO) (or other Tribal officer), and the Advisory Council on Historic Preservation have executed a Programmatic Agreement (PA) to comply with Section 106 of the National Historical Preservation Act. Stipulations of the PA include requirements that Longhorn enter into consultation with the SHPO/THPO to identify all National Register or eligible archaeological or historic properties that may be affected directly, or indirectly by subsequent ground disturbing activities. Where adverse impacts cannot be avoided, resource recovery plans are to be developed and implemented. A copy of the PA can be found in Appendix 7J.

4.4.2 Austin Re-route Alternative

Available data were researched to determine the presence of archaeological and historical resources within the Austin Re-route corridor. The area evaluated included a 2,000-ft-wide corridor along the alignment, south of populated areas of the Austin metropolitan area. Data sources were: (1) the map and site files at the Texas Archeological Research Laboratory (The University of Texas at Austin) for recorded archeological sites; (2) the Texas Historical Commission's online Texas Historic Sites Atlas for properties listed in the *National Register*; and (3) the 1910 USGS 15-minute quadrangle (Austin, TX; fieldwork performed in 1995-1996) for potential historic archeological sites (USGS, 1910).

Nine archaeological sites have been recorded along or within the 2,000-ft-wide corridor. Four sites (41HY211, 41HY212, 41HY213, and 41HY214) are in Hays County, and five (41TV855, 41TV1425, 41TV1426, 41TV1537, and 41TV1538) are in Travis County. These are summarized in the following text.

41HY211 consists of chipped stone debris on the surface over an area of approximately 1,300 by 500 ft. The site is considered to be a lithic procurement site with little or no subsurface deposits.

41HY212 consists of chipped stone debris observed on the surface over an area of approximately 2,100 by 1,000 ft and was interpreted to be a lithic procurement site with little or no subsurface deposits.

41HY213 consists of chipped stone debris observed on the surface over an area of approximately 1,300 by 330 ft and was interpreted as a lithic procurement site with little or no subsurface deposits.

41HY214 consists of chipped stone debris on the surface over an area of approximately 1,200 by 1,000 ft. It was interpreted to be a lithic procurement site with little or no subsurface deposits.

41TV855 consists of an isolated prehistoric artifact (a chert biface) found approximately 500 ft northeast of the Austin Re-route Alternative.

41TV1425 consists of chipped stone debris and burned rocks that were observed on the surface over an area of approximately 65 by 65 ft. It was interpreted to be a small open campsite with little or no subsurface deposits.

41TV1426 consists of a rock and brick foundation; bricks, glass, and metal were observed on the surface over an area of approximately 50 by 50 ft. The site was interpreted to be an early-twentieth-century house site, although sparseness of artifacts made age assessment difficult.

41TV1537 consists of chipped stone debris that was observed on the surface over an area of at least 900 by 500 ft. The site was interpreted as an eroded lithic procurement site with little or no subsurface deposits.

41TV1538 consists of chipped stone debris observed on the surface over an area of at least 1,100 by 700 ft. The site was interpreted as an eroded lithic procurement site with little or no subsurface deposits.

National Register Properties

Forty-one properties in Hays County and 129 in Travis County are listed in the *National Register*. The Austin Re-route Alternative would have no impact to these sites. The listed property that is closest to the Austin Re-route is the McKinney Homestead in McKinney Falls State Park, approximately 2.2 miles northwest of the eastern end of the route.

Potential Historic Archaeological Sites

The 1910 USGS quadrangle shows that there were at least 10 buildings along or close to the Austin Re-route Alternative at the turn of the century. These probably represent farmsteads or house sites. These locales could contain historic archaeological sites relating to these buildings.

The presence of eight prehistoric sites and one historic site within the 2,000-ft-wide corridor appear to consist of scatters of lithic debris with little or no subsurface deposits. Because of their apparently surficial nature, they are unlikely to contain the kinds of information that would make them eligible for listing in the National Register or designation as State Archeological Landmarks. Nonetheless, several of these are in settings where important cultural features, such as burned rock middens, could occur.

4.4.3 El Paso Laterals

Cultural resource investigations were conducted along the proposed Fort Bliss alignment in preparation of construction across federal property. The investigations noted eight archaeological sites in the vicinity of the pipeline alignment (Barrera, 1999), and the ROW was shifted to avoid potential construction-related impacts to these sites.

No cultural resource investigations were conducted for the Montana Avenue alignment, which would parallel existing roadway ROW previously disturbed through highway construction and land development.

4.5 REFERENCES

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