6. JEWETT SITE

6.1 CHAPTER OVERVIEW

This chapter provides information regarding the affected environment and the potential for impacts on each resource area in relation to construction and operation of the FutureGen Project at the proposed Jewett Site. To aid the reader and to properly address the complexity of the FutureGen Project, as well as the need to evaluate four sites (two in Illinois and two in Texas), this Environmental Impact Statement (EIS) was prepared as two separate volumes. Volume I of the EIS includes the purpose and need for the agency action, a description of the Proposed Action and Alternatives, and a summary of the potential environmental consequences. Volume II addresses the affected environment and potential impacts for each of the four proposed alternative sites. Presenting the affected environment immediately followed by the potential impacts on each resource area allows the reader to more easily understand the relationship between current site conditions and potential project impacts on a particular resource.

Volume II is organized by separate chapters for each proposed site: Chapter 4-Mattoon, Illinois; Chapter 5-Tuscola, Illinois; Chapter 6-Jewett, Texas; and Chapter 7-Odessa, Texas.

This chapter is organized by resource area as follows:

- 6.2 Air Quality
- 6.3 Climate and Meteorology
- 6.4 Geology
- 6.5 Physiography and Soils
- 6.6 Groundwater
- 6.7 Surface Water
- 6.8 Wetlands and Floodplains
- 6.9 Biological Resources
- 6.10 Cultural Resources
- 6.11 Land Use
- 6.12 Aesthetics
- 6.13 Transportation and Traffic
- 6.14 Noise and Vibration
- 6.15 Utility Systems
- 6.16 Materials and Waste Management
- 6.17 Human Health, Safety, and Accidents
- 6.18 Community Services
- 6.19 Socioeconomics
- 6.20 Environmental Justice

Each resource section provides an introduction, describes the region of influence (ROI) and the method of analysis, and discusses the affected environment and the environmental impacts from construction and operation of the FutureGen Project at the candidate site. The affected environment discussion describes the current conditions at the proposed power plant site, sequestration site, and utility and transportation corridors. This is followed by a discussion of potential construction and operational impacts. A summary and comparison of impacts for all four candidate sites are provided in the EIS Summary and in Chapter 3. Unavoidable adverse impacts, mitigation measures, and best management practices (BMPs) for all four candidate sites are also provided in Chapter 3.

6.1.1 POWER PLANT FOOTPRINT

The specific configuration of the power plant, rail loop, and access roads within the candidate sites would be determined after site selection, during the site-specific design phase. For purposes of analysis, the impact assessment for the proposed power plant site assumed a representative configuration or layout depicted in Chapter 2, Figure 2-18. The proposed power plant site would involve up to 200 acres (81 hectares) to house the power plant, coal and equipment storage, associated processing facilities, research facilities, railroad loop surrounding the power plant envelope, and a buffer zone; the site could ultimately be located anywhere within the larger power plant parcel. Therefore, impact discussions in this chapter identify environmentally sensitive areas to be avoided and address potential impacts to be evaluated, avoided, or mitigated within the entire power plant parcel.

6.1.2 NO-ACTION ALTERNATIVE

As discussed in Chapter 2, Proposed Action and Alternatives, the No-Action Alternative is treated in this EIS as the "No Build" Alternative. That is, under the No-Action Alternative, the Alliance would not undertake a FutureGen-like project in the absence of Department of Energy (DOE) funding assistance. In the unlikely event that the Alliance did undertake a FutureGen-like project in the absence of DOE funding assistance, impacts might be similar to those predicted in this EIS. However, the Alliance would not be subject to the oversight or the mitigation requirements of DOE.

One goal of the FutureGen Project would be to test and prove a technological path toward minimization of greenhouse gas (GHG) emissions from coal-fueled electric power plants. Should the FutureGen Project prove successful and the concept of carbon dioxide (CO_2) capture and geologic sequestration receive widespread application across the U.S. and around the world, the current trend of increasing CO_2 emissions to the atmosphere from coal-fueled power plants could be reduced. In the absence of concept proof, industry and governments may be unwilling to initiate all of the technological changes that would help to significantly reduce current trends and consequential increase of CO_2 concentrations in the Earth's atmosphere.

Impacts associated with the No-Action Alternative are provided in Chapter 3.

6.1.3 JEWETT SITE

The proposed Jewett Site is located in east-central Texas on approximately 400 acres (162 hectares) of formerly mined land northwest of the Town of Jewett. Key features of the Jewett Site are listed in Table 6*.1-1*. The proposed site is located at the intersection of Leon, Limestone, and Freestone counties, and bordered by Farm-to-Market Road (FM) 39. The Burlington Northern Santa Fe Railroad runs along the northeastern border of the proposed site. Potable water and process water would be obtained by drilling new wells on site or nearby. Sanitary wastewater would be treated through a new on-site wastewater treatment system. The proposed power plant would connect to the power grid via existing high voltage transmission lines. Natural gas would be delivered through an existing gas pipeline located at the northeastern corner of the proposed plant site. The proposed sequestration injection wells would be located on both private ranchland and state-owned prison land approximately 33 miles (53.1 kilometers) northeast of the proposed power plant site. A new CO_2 pipeline would be installed largely along existing ROWs, but would require some new ROWs. Following Table 6*.1-1*, Figures 6*.1-1*, 6*.1-2,* and 6*.1-3* illustrate the Jewett Power Plant Site, utility corridors, and sequestration site, respectively.

Proposed Jewett Power Plant Site

(NRG Limestone Generating Station in the background)

Table 6.1-1. Jewett Site Features

Feature	Description
Power Plant Site	The proposed Jewett Site is located in east-central Texas on approximately 400 acres (162 hectares) of land northwest of the Town of Jewett. The proposed site is located at the intersection of Leon, Limestone, and Freestone counties on FM 39 near US 79. The area is characterized by very gently rolling reclaimed mine lands immediately adjacent to an operating lignite mine and the nominal 1800-MW NRG Limestone Generating Station (power plant). The Site Proponent is the State of Texas. The proposed power plant site is currently held by one property owner – NRG Texas.
Sequestration Site Characteristics and Predicted Plume Radius	***The proposed Jewett Sequestration Site includes three proposed injection wells located in a rural area about 33 miles (53 kilometers) northeast of the proposed power plant site. Two of the proposed injection well sites are located about 16 miles (28 kilometers) east of the Town of Fairfield in Freestone County, about 60 miles east of Waco. The third proposed injection well site is about 5 miles (8 kilometers) east on Texas Department of Criminal Justice (TDCJ) property in Anderson County about 16 miles (28 kilometers) west of the City of Palestine.*** The land use at the proposed sequestration site is primarily agricultural, with few residences located over the projected plume. Injection would occur on a private ranch (Hill Ranch) and on adjoining state property managed by the TDCJ. Two injection wells are proposed for injection into the Woodbine formation. In addition, one more injection well is proposed for injection into the deeper Travis Peak formation at a much lower injection rate than the primary Woodbine wells to take advantage of CO_2 sequestration research opportunities on low permeability reservoirs. The Travis Peak well would not be required in addition to the Woodbine injection wells to accommodate the output of the proposed power plant. One of the Woodbine injection wells and the Travis Peak well would be located on the Hill Ranch property. The other Woodbine injection well would be located on TDCJ property. Under the proposed injection plan, each of the Woodbine wells would be used to inject 45 percent of the total CO_2 output with the remaining 10 percent injected into the Travis Peak well. Both the Woodbine and Travis Peak formations lie beneath a primary seal, the Eagle Ford Shale, which has a thickness of 400 feet (122 meters). The primary injection zone, the Woodbine sandstone, is directly beneath the Eagle Ford. There are also over 0.4 mile (0.6 kilometer) of low permeability carbonates and shales above the Eagle Ford that create additional protection for shallow ***underground sources of drinking water***. The injection depth within the Woodbine formation would be 1 to 1.1 miles (1.6 to 1.8 kilometers). Injection into the Travis Peak formation would occur between 1.7 to 2.1 miles (2.7 to 3.4 kilometers) below the ground surface. To estimate the size of the plume of injected CO_2, the Alliance used numerical modeling to predict the plume radius from the injection wells. This modeling estimated that the plume radius at the proposed Jewett injection site could be as large as 1.7 miles (2.7 kilometers) per Woodbine injection well, 50 years after injecting 2.8 million tons (2.5 MMT) of CO_2 annually for the first 20 years, followed by 30 years of gradual plume spreading. The dispersal and movement of the injected CO_2 would be influenced by the geologic properties of the reservoir, and it is unlikely that the plume would radiate in all directions from the injection point in the form of a perfect circle. However, for reference purposes, this modeled radius corresponds to a circular area equal to 5,484 acres (2,219 hectares). A total of 10,968 acres (4,439 hectares) is estimated for all three wells.
Utility Corridors	
Potable Water	Potable water would be supplied in the same manner as the proposed plant's process water, by installing new wells either on the property or off site. This would require 1 mile (1.6 kilometers) of new construction.
Process Water	Process water would be provided by installing wells on the proposed site or possibly off site into the Carrizo-Wilcox Aquifer. Because the wells would be located on or close to the proposed plant site, only a small length of distribution pipeline, less than 1 mile (1.6 kilometers), would be required to deliver water to the proposed plant.

Table 6.1-1. Jewett Site Features

Feature	Description
Sanitary Wastewater	Sanitary wastewater would be treated and disposed of through construction and operation of an on-site sanitary WWTP. Effluent from the WWTP would be treated and disposed of in accordance with local and state regulations or recycled back into the power plant for process water.
Electric Transmission Lines	Option 1: The proposed power plant would connect to a 345-kV transmission line bordering the plant site. Option 2: The proposed power plant would connect to a 138-kV line approximately 2 miles (3.2 kilometers) from the site on a new ROW.
Natural Gas	Natural gas would be delivered through an existing natural gas pipeline located at the northwestern corner of the proposed power plant site. This pipeline is owned and operated by Energy Transfer Corporation.
CO_2 Pipeline	A new CO_2 pipeline would be required to connect the proposed power plant site to the proposed sequestration site. The pipeline would be up to 59 miles (95.0 kilometers) in length and the ROW would be approximately 20 to 30 feet (6.1 to 9.1 meters) wide. The proposed CO_2 pipeline has been divided into the following common segments, except for segments A-C and B-C, which are alternatives between the proposed plant site and the beginning of segment C: • Segment A-C would begin on the northeastern side of the proposed plant site and follow 2 miles (3.2 kilometers) of existing ROW owned by the Burlington Northern – Santa Fe Railroad. It would continue approximately 3 miles (4.8 kilometers) along a new ROW until it intersects a section of a natural gas pipeline ROW. The corridor would then follow this pipeline another 3 miles (4.8 kilometers) east until it joins a larger trunk of a natural gas pipeline. • Segment B-C would begin along the southern boundary of the proposed plant site and extend southeast approximately 2.5 miles (4.0 kilometers) along FM 39. It then would turn northeast and follow the existing ROW of a natural gas pipeline for another 4 miles (6.4 kilometers) until it joins a ROW for a larger trunk of a natural gas pipeline that extends northwest for approximately 8 miles (12.9 kilometers). • Segment C-D would follow an existing natural gas line ROW northward for approximately 15 miles (24.1 kilometers). • Segment D-E is no longer being evaluated for this project; therefore, it is not addressed in this EIS. • Segment D-F would continue northward along the existing natural gas line ROW for another 9 miles (14.5 kilometers). • Segment F-G would extend in a straight line east along a new ROW approximately 6 miles (9.7 kilometers) to the proposed sequestration wells on the Hill Ranch. • Segment F-H would continue northward along the existing natural gas line corridor for almost 2 miles (3.2 kilometers) where it would cross the Trinity River to the north side. It then would intersect another leg of a natural gas pipeline ROW and continue east for approximately 6 miles (9.7 kilometers). The line would then continue in a generally eastward direction along a county highway (CH) ROW and TDCJ land for approximately another 6 miles (9.7 kilometers) to the proposed injection well site on TDCJ land.

Table 6.1-1. Jewett Site Features

Feature	Description
Transportation Corridors	The proposed Jewett Site is bordered by FM 39, which intersects US 79 and State Highway (SH) 164 within 10 miles (16.1 kilometers) of the site boundary. The Burlington Northern – Santa Fe Railroad also runs along the northeastern border of the proposed power plant site. Texas is located in the West South Central Demand Region for coal, which also includes Louisiana, Arkansas, and Oklahoma. According to the Energy Information Administration (EIA, 2000), the West South Central Demand Region receives the majority of its coal resources from the PRB and the Rockies. In 1997, the average distance that a coal shipment traveled to reach a destination in this region was about 1,300 miles (2,092 kilometers) (EIA, 2000). In terms of a straight line distance, Jewett is approximately 950 miles (1,529 kilometers) from the Pittsburgh Coalbed (south-central Ohio in the northern Appalachian Basin), 650 miles (1,046 kilometers) from the Illinois Basin coals (southern Illinois), and 1,000 miles (1,609 kilometers) from the PRB coal supplies (eastern Wyoming). In addition, Texas lignite is available from the on-site Westmoreland Coal Company mine and perhaps other regional mines.

Source: FG Alliance, 2006c (unless otherwise noted).

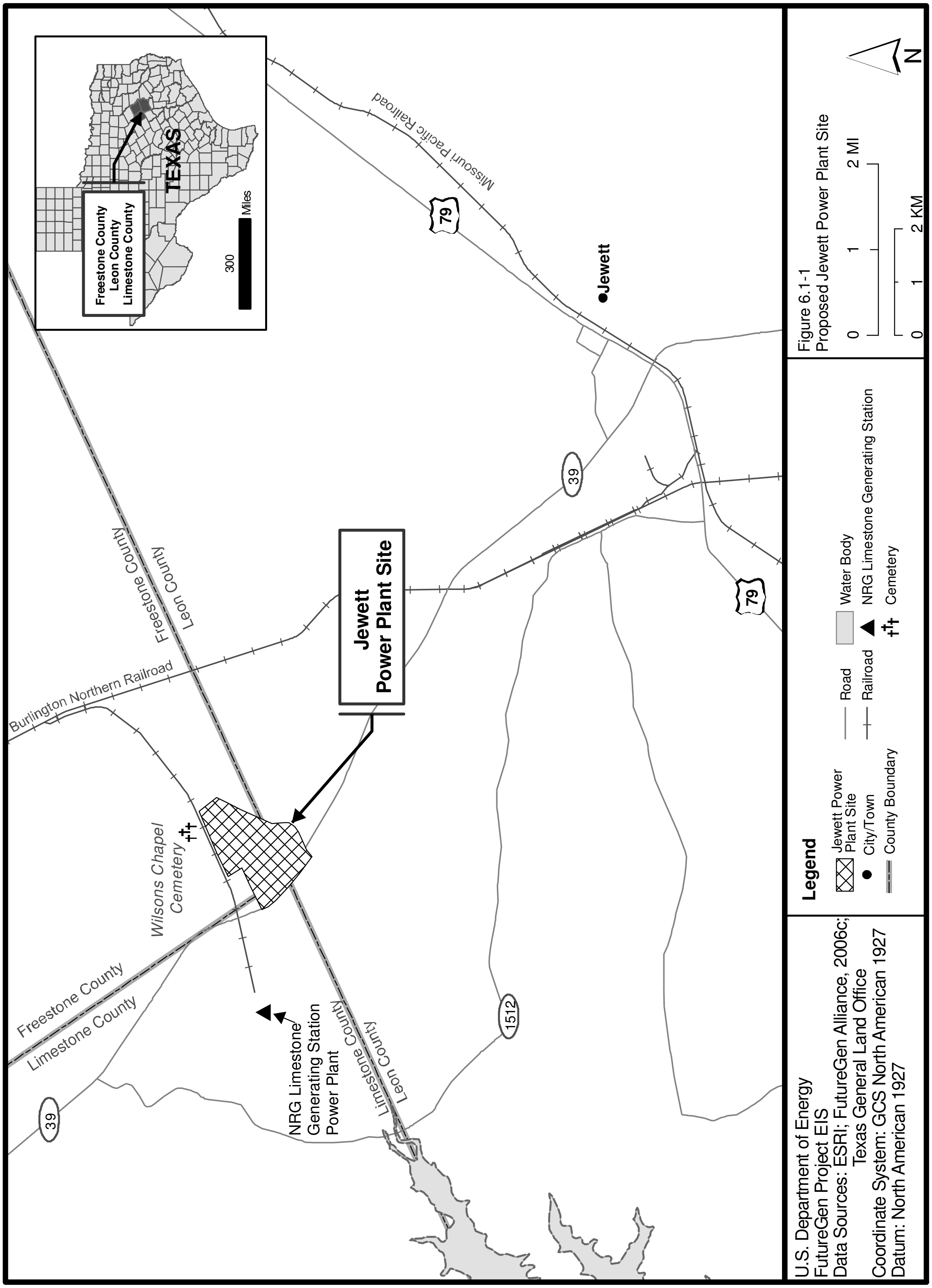

Figure 6.1-1
Proposed Jewett Power Plant Site

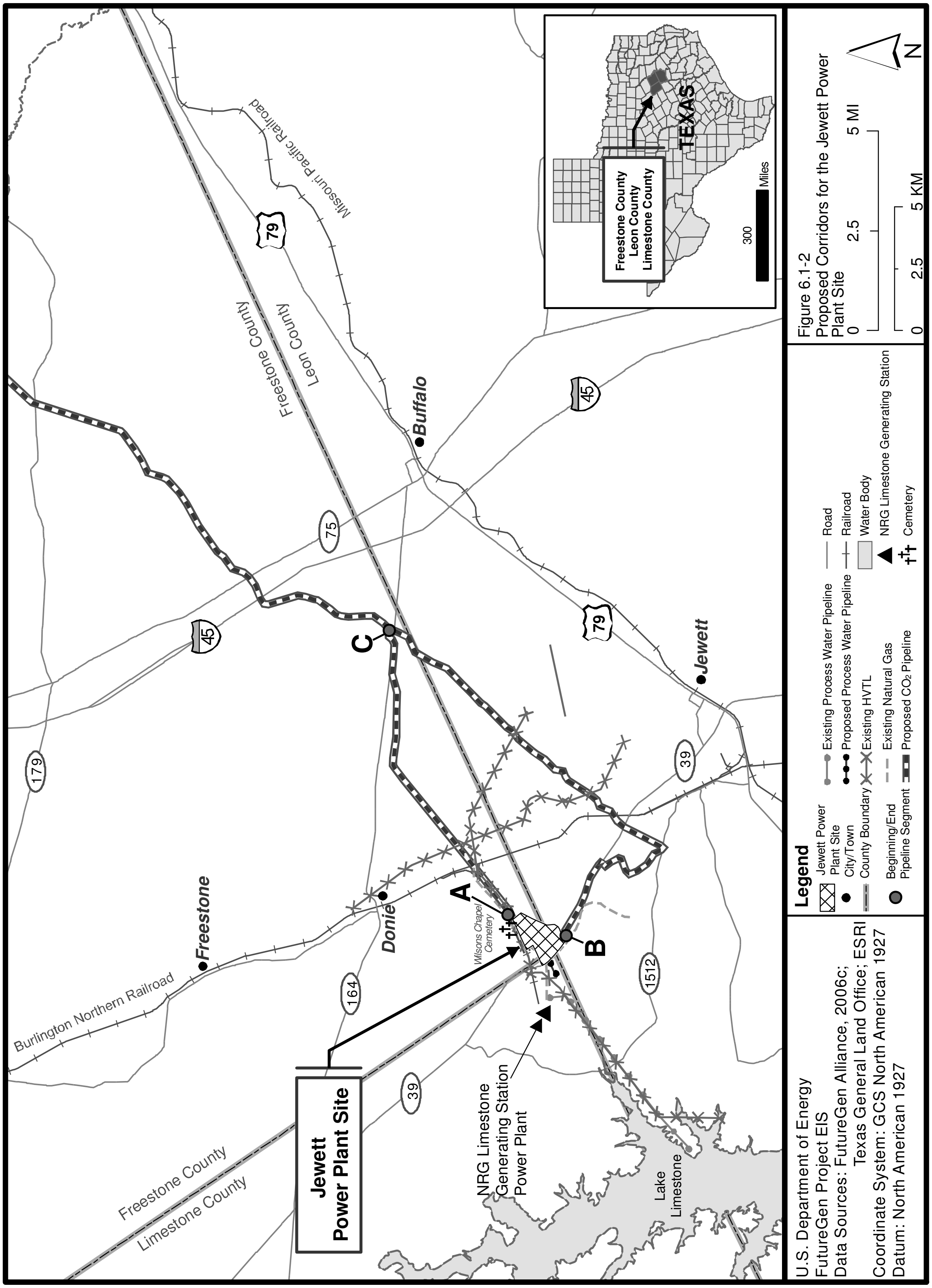

Figure 6.1-2
Proposed Corridors for the Jewett Power Plant Site

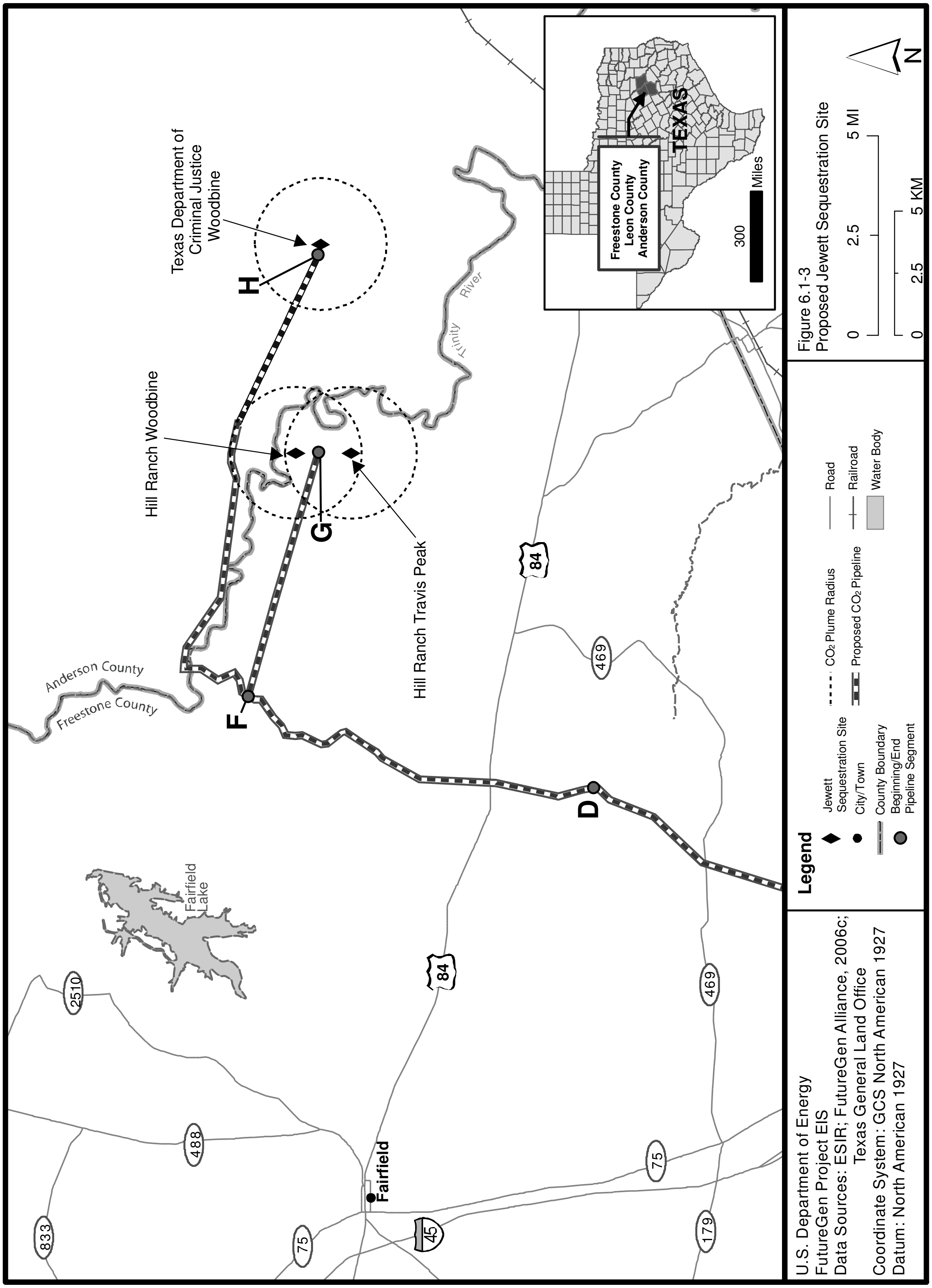

Figure 6.1-3
Proposed Jewett Sequestration Site

6.2 AIR QUALITY

6.2.1 INTRODUCTION

This section describes existing local and regional air quality and the potential impacts that may occur from constructing and operating the FutureGen Project at the Jewett Power Plant Site and sequestration site. The FutureGen Project would use integrated gasification combined-cycle (IGCC) technology and would capture and sequester carbon dioxide (CO_2) in deep underground formations. Chapter 2 provides a discussion of the advancements in IGCC technology associated with the FutureGen Project that would reduce emissions of air pollutants. Because of these technologies, emissions from the FutureGen Project would be lower than emissions from existing IGCC power plants and state-of-the-art (SOTA), conventional coal-fueled power plants.

6.2.1.1 Region of Influence

The ROI for air quality includes the area within 50 miles (80.5 kilometers) of the boundaries of the proposed Jewett Power Plant Site and within 50 miles (80.5 kilometers) of the boundaries of the proposed Jewett Sequestration Site. Sensitive receptors that have been identified within the ROI are discussed in Section 6.2.2.3.

6.2.1.2 Method of Analysis

DOE reviewed available public data and also studies performed by the Alliance to determine the potential for impacts based on whether the proposed FutureGen Project would:

- Result in emissions of criteria pollutants and hazardous air pollutants (HAPs);
- Result in mercury (Hg) emissions and conflict with the Clean Air Mercury Rule (CAMR) as related to coal-fueled electric utilities;
- Cause a change in air quality related to the National Ambient Air Quality Standards (NAAQS);
- Result in consumption of Prevention of Significant Deterioration (PSD) increments as defined by the Clean Air Act (CAA), Title I, PSD rule;
- Affect visibility and cause regional haze in Class I areas;
- Result in nitrogen and sulfur deposition in Class I areas;
- Conflict with local or regional air quality management plans;
- Result in emissions of greenhouse gases (GHGs);
- Cause solar loss, fogging, icing, or salt deposition on nearby residences; and
- Discharge odors into the air.

> **Plant upset** is a serious malfunction of any part of the IGCC process train and usually results in a sudden shutdown of the combined-cycle unit's gas turbine and other plant components.

Based on the above criteria, DOE assessed potential air quality impacts from construction and operational activities related to the FutureGen Project at the proposed Jewett Power Plant Site and sequestration site. For impacts related to FutureGen Project operations, DOE conducted air dispersion modeling for criteria pollutants using EPA's refined air dispersion model, AERMOD (American Meteorological Society/EPA Regulatory Model). Details on the air modeling protocol are presented in Appendix E. To establish an upper bound for potential impacts, DOE used the FutureGen Project's estimate of maximum air emissions, which was developed by the Alliance and reviewed by DOE, for the air dispersion modeling based on 85 percent plant availability and unplanned restarts as a result of plant upset (also called unplanned outages) (see Table 6.2-1). The estimate of maximum air emissions was developed using the highest pollutant emission rates for various technology options being considered for the FutureGen Project (see Section 2.5.1.1). Surrogate data from similar existing or permitted units (e.g., the Orlando Gasification Project [Orlando Project]) were used for instances where engineering details and emission data were not available due to the early design stage of the FutureGen Project (DOE, 2007). ***However, a power plant built with these conceptual designs, under normal steady-state operations, could meet the specified FutureGen Project Performance Targets (see Section 2.5.6).***

Table 6.2-1 presents expected emissions of air pollutants from the FutureGen Project during the 4-year research and development period and beyond. Emissions from the first year of the proposed power plant operation, which are expected to be highest, represent the upper bound for potential air emissions and were modeled for this EIS. Emissions would be expected to decrease each year, as learning and experience would reduce the frequency and types of unplanned restart events from an estimated 29 in the first year to 3 in the fifth year and beyond (see Appendix E). Consequently, annual emissions would be expected to decrease progressively from the first year of operation to the fourth year of operation and beyond. Because emissions of some criteria pollutants are projected to exceed 100 tons per year (tpy) (90.7 metric tons per year [mtpy]) (even with less than 3 restarts per year), the FutureGen Project would be classified as a major source under Clean Air Act regulations.

Table 6.2-1. Yearly Estimates of Maximum Air Emissions from the FutureGen Project[1] (tpy [mtpy])

Pollutant	Year 1	Year 2	Year 3	Year 4	Year 5 Onward[2]
Sulfur Oxides[3] (SO_x)	543 (492)	322 (292)	277 (251)	255 (231)	100 (90.7)
Nitrogen Oxides[4] (NO_X)	758 (687)	754 (684)	753 (683)	753 (683)	750 (680.4)
Particulate Matter[5] (PM_{10})	111 (100)	111 (100)	111 (100)	111 (100)	111 (100.7)
Carbon Monoxide[5] (CO)	611 (554)	611 (554)	611 (554)	611 (554)	611 (554.3)
Volatile Organic Compounds[5] (VOCs)	30 (27.2)	30 (27.2)	30 (27.2)	30 (27.2)	30 (27.2)
Mercury[5] (Hg)	0.011 (0.01)	0.011 (0.01)	0.011 (0.01)	0.011 (0.01)	0.011 (0.01)

[1] Because the FutureGen Project would be a research and development project, DOE assumes that the maximum facility annual availability would be 85 percent. Values are estimated based on maximum emissions rates for design Case 1, 2, or 3A, plus maximum emissions rates for design Case 3B and includes emissions from unplanned restarts (upset conditions).
[2] Year 1 to Year 4 calculated based on information provided by the Alliance. Year 5 estimated by DOE, not provided by the Alliance.
[3] SO_x emissions from coal combustion systems are predominantly in the form of sulfur dioxides (SO_2).
[4] NO_x emissions from coal combustion are primarily nitric oxide (NO); however, for the purpose of the air dispersion modeling, it was assumed that all NO_x emissions are nitrogen dioxides (NO_2). One of the technologies being considered for the FutureGen Project is post-combustion selective catalytic reduction (SCR), which would reduce the annual NO_X emissions to 252 tpy (228.6 mtpy).
[5] Values for PM_{10}, CO, VOCs, and Hg would remain constant between Year 1 through 5 because unplanned restarts would not affect these emissions. Conversely, SO_2 and NO_2 emissions would decrease each year due to expected decrease in restart events. See Appendix E, Tables E-2 and E-3.
tpy = tons per year; mtpy = metric tons per year.
Source: FG Alliance, 2007.

In addition to assessing impacts of criteria pollutant emissions, DOE assessed impacts of HAP emissions by estimating the annual quantities of HAPs that would be emitted from the proposed FutureGen Power Plant. These estimates were developed based on emissions predicted for the Orlando Project, which would burn a carbon-rich syngas (DOE, 2007). The estimated HAPs may be overstated since the FutureGen Project would include new technologies that would produce syngas that would contain lower levels of carbon. The estimated emissions are presented in Section 6.2.3.2.

DOE also assessed the potential for impacts to local visibility from the vapor plume using qualitative measures because engineering specifications needed to conduct quantitative modeling for vapor plume sources (e.g., cooling towers) were not available. Class-I-related modeling, including pollutant dispersion and air-quality-related values (AQRV), were reviewed for their applicability. Potential effects to soil, vegetation, animals, human health, and economic development were also reviewed.

6.2.2 AFFECTED ENVIRONMENT

6.2.2.1 Existing Air Quality

The Texas Commission on Environmental Quality's (TCEQ) Monitoring Operations Division has monitoring sites throughout the state, which monitor ambient air quality and designate areas or regions that either comply with all of the NAAQS or fail to meet the NAAQS for one or more criteria pollutants. The NAAQS specify the maximum allowable concentrations of six criteria pollutants: sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), ozone (O_3), lead (Pb), and inhalable particles, which are also known as respirable particulate matter (PM). The PM_{10} standard covers particles with diameters of 10 micrometers or less and the $PM_{2.5}$ standard covers particles with diameters of 2.5 micrometers or less. Areas that meet the NAAQS for a criteria pollutant are designated as being in "attainment" for that pollutant, and areas where a criteria pollutant concentration exceeds the NAAQS are designated as "non-attainment" areas. Where insufficient data exist to determine an area's attainment status, the area is designated as unclassifiable. Maintenance areas are those non-attainment areas that have been redesignated as attainment areas and are under a 10-year monitoring plan to maintain their attainment status.

The proposed Jewett Power Plant Site is located at the juncture of Leon, Freestone, and Limestone counties in Texas. The surface extent of the proposed sequestration site is located within Freestone and Anderson counties. Leon, Freestone, and Limestone counties are part of the Austin-Waco Intrastate Air Quality Control Region (AQCR) and Anderson County is part of the Shreveport-Texarkana-Tyler Interstate AQCR. No ambient air quality monitors are in operation within the ROI of the proposed Jewett Power Plant Site (FG Alliance, 2006c). Although monitors were placed within the ROI in both Bell County (in the Austin-Waco Intrastate AQCR) and Anderson County during 2005, these monitors collected O_3 data and were deactivated in 2006; however, the Austin-Waco Intrastate and Shreveport-Texarkana-Tyler Interstate AQCRs have no history of non-attainment for the six criteria pollutants. The nearest permanent NAAQS monitors are located in Dallas County (Metropolitan Dallas-Fort Worth Interstate AQCR), Harris County (Metropolitan Houston-Galveston Intrastate AQCR), and Smith County (Shreveport-Texarkana-Tyler Interstate AQCR). These monitors are all located in O_3 non-attainment areas or near non-attainment areas. These permanent monitors are influenced by local sources, and may not be representative of conditions in and around the proposed power plant site (FG Alliance, 2006c). The closest $PM_{2.5}$ monitor within an attainment area is in Harris County. The most recent available data from monitoring stations nearest to the project site are presented in Table 6.2-2. ***Appendix E provides additional details.***

While the ROI for the proposed project is currently designated as in attainment or unclassified, air moving from nearby non-attainment areas could likely contribute to the air quality within the region of the proposed Jewett Power Plant Site. The proposed power plant site is more than 58 miles (93.3 kilometers) away from the border of the nearest designated non-attainment area. Site-specific monitoring to collect representative background data for all criteria pollutants could be required at the proposed project site as part of the PSD permit application process (EPA, 1990). The Alliance may choose to conduct site-specific monitoring for criteria pollutants as appropriate for development of a detailed site characterization if the proposed Jewett Site is selected.

Table 6.2-2. Monitoring Stations and Ambient Air Quality Data

Monitoring Site Location	Distance from Proposed Site (miles [kilometers])	Pollutant and Averaging Time	Monitored Data[1]	Primary/ Secondary Standard[1]
Tyler Airport, Tyler, TX Smith County Shreveport-Texarkana-Tyler Interstate AQCR	85 (136)	O_3 (1-hour) O_3 (8-hour)	0.104 0.089	0.12 0.08
Dallas North, TX Dallas County Metropolitan Dallas-Fort Worth Intrastate AQCR	105 (169)	O_3 (1-hour) O_3 (8-hour) NO_2 (Annual)	0.103 0.091 ***26.34***	0.12 0.08 ***100***
Houston – Aldine, TX Harris County Metropolitan Houston-Galveston Intrastate AQCR	115 (185)	O_3 (1-hour) O_3 (8-hour) $PM_{2.5}$ (Annual)[2] $PM_{2.5}$ (24-hour)[2]	0.153 0.111 13.7 29.3	0.12 0.08 15 35

[1] Units for $PM_{2.5}$ ***and*** NO_2 are in micrograms per cubic meter (µg/m^3), units for O_3 ***is*** in parts per million (ppm). To determine representative background data for $PM_{2.5}$ 24 hours and annual averaging periods, the monitored data are averaged over a period of three years (2003 to 2005). For all other pollutants and corresponding averaging periods, the highest of the second-highest values each year for a period of three years (2003 to 2005) is used (see Appendix E).
Source: EPA, 2006a.

6.2.2.2 Existing Sources of Air Pollution

Emissions from the proposed FutureGen Project and potential environmental consequences must be considered in the context of both regional air quality and existing local sources of emissions. Existing sources of emissions outside and within the ROI are discussed. Additionally, local sources (i.e., within 1 mile [1.6 kilometers] of the proposed Jewett Power Plant Site and sequestration site) are discussed.

Outside the Region of Influence

Traffic-related pollution and pollution from existing industrial sources associated with nearby large cities are some of the causes of non-attainment areas in several locations near the margin of the ROI. The proposed Jewett Power Plant Site and sequestration site have the large cities and urban areas of Dallas and Fort Worth to the north-northwest, Waco to the west, Austin to the southwest and Houston to the south-southeast, all of which are outside the ROI. These urban areas could likely impact air quality within the ROI and probably account for some portion of the background concentrations of pollutants.

Inside the Region of Influence

The only large population areas within the ROI include the City of Corsicana and small portions of the cities of Waco and College Station. The remainder of the ROI contains small towns and communities distributed throughout the rural region. The types and quantities of air pollutants emitted from existing sources located within 10 miles (16.1 kilometers) of the proposed power plant site may contribute to the background concentrations of pollutants within and surrounding the ROI. According to the 2004 Air Emissions Inventory, the major sources of criteria pollutants and HAPs within a 10-mile (16.1-kilometer) radius are the Nucor's Jewett Steel Mill, NRG Limestone Electric Generating Station, and XTO Energy Freestone Central Station (FG Alliance, 2006c). These existing sources, also considered major sources, provide a context for understanding the potential emissions and associated air quality impacts from the proposed project.

A **major source** is ***generally*** a unit that emits any one criteria pollutant in amounts equal to or greater than thresholds of 100 tpy (90.7 mtpy) or one HAP in amounts greater than or equal to 10 tpy (9.1 mtpy) or a combination of HAP in amounts greater than or equal to 25 tpy (22.7 mtpy). For sources that are not in one of the 28 categories ***defined by the PSD rule,*** the threshold is 250 tpy (226.8 mtpy) of criteria pollutants (40 Code of Federal Regulations [CFR] 52.21, 2006). ***Because a fossil-fuel fired steam electric generating unit is one of the 28 categories defined by the PSD rule, the 100 tpy threshold applies.***

Local

There are several existing sources within 1 mile (1.6 kilometers) of the proposed Jewett Power Plant Site. The vicinity of the proposed power plant site is mostly rural with a low to very low population density, and light to very light traffic loads on nearby roads. The Texas Westmoreland Coal Company's Jewett Surface Lignite Mine (Jewett Mine) operates along the southeastern side of the proposed power plant site, extending along a line running from southwest to northeast. Much of the mine land is reclaimed, but active surface mining is ongoing at a pit located 0.7 mile (1.1 kilometers) or more to the south and southwest of the proposed Jewett Power Plant Site. An active coal mine haul road traverses the southeastern border of the proposed power plant site, connecting the active pits with a rail loading facility and with the mine maintenance shop and office complex located across FM 39 from the proposed plant site. Fugitive dust (i.e., PM_{10}) and diesel emissions (i.e., PM_{10}, CO, NO_X, SO_2, and VOCs) are generated in these areas. The 766-MW lignite-fueled NRG Limestone Electric Generating Station, Units 1 and 2, is a major source and is located 0.8 mile (1.3 kilometers) west of the proposed Jewett Power Plant Site. The Limestone Electric Generating Station stores ash in a large pile located 0.4 mile (0.6 kilometer) or more to the north, and this pile likely constitutes a local source of dust. Gas wells and unpaved service roads are scattered across the landscape surrounding the proposed power plant site. Traffic on these unpaved roads, along with other unpaved roads that provide farm and residential access, constitute a source of fugitive dust. Relatively little agriculture occurs in this area, though some ranching occurs. Agriculture and ranching appear to be relatively minor fugitive dust contributors.

CO_2 sequestration would use at least three injection sites totaling approximately 1,550 acres (626 hectares) over two properties. Eight small communities or towns exist within the area, but most of the land is characterized as forest and grasslands. The vicinity of the proposed CO_2 sequestration activities is mostly ranchland, with some forest land and few residences. Some roads, especially ranch roads, are unpaved. Both the ranching and local traffic likely constitute a source of fugitive dust emissions.

6.2.2.3 Sensitive Receptors (Including Class I Areas)

There are no residences within 0.3 mile (0.5 kilometer) of the proposed Jewett Power Plant Site. One small church is located approximately 0.3 mile (0.5 kilometer) north of the northern corner of the proposed power plant site. The church building appears to have very limited use, and it is unclear whether this church building continues to serve as a place of regular worship services. Within 1 mile (1.6 kilometers) of the power plant site, the density of residences is very low, and no sensitive receptors were identified other than the church. There are no sensitive receptors within 1 mile (1.6 kilometers) of the proposed sequestration site.

Within the 10-mile (16.1-kilometer) radius of the proposed Jewett Power Plant Site, there are five schools (FG Alliance, 2006c). Within 10 miles (16.1 kilometers) of the proposed Jewett Sequestration Site, there are 16 sensitive receptors (see Figure 6.2-1), including four schools, one university campus, three day care centers, two hospitals, one retirement center, and five prisons (FG Alliance, 2006c).

Class I Areas

For areas that are already in compliance with the NAAQS, the PSD requirements provide maximum allowable increases in concentrations of pollutants, which are expressed as increments. Allowable PSD increments currently exist for three pollutants: SO_2, NO_2, and PM_{10}. They apply to the three types of areas classified under the PSD regulations: Classes I, II, and III, where the smallest allowable increments correspond to Class I areas (Table 6.2-3).

Table 6.2-3. Allowable PSD Increments (μg/m^3)

Pollutant, averaging period		Class I Area	Class II Area	Class III Area
SO_2	3-Hour	25	512	700
	24-Hour	5	91	182
	Annual	2	20	40
NO_2	Annual	2.5	25	50
PM_{10}	24-Hour	8	30	60
	Annual	4	17	34

μg/m^3 = micrograms per cubic meter.
Source: EPA, 2005.

Class I areas, which are those areas designated as pristine, require more rigorous safeguards to prevent deterioration of the air quality, and include many national parks and monuments, wilderness areas, and other areas as specified in 40 CFR 51.166(e). The closest Class I area is 240 miles (386.2 kilometers) from the proposed Jewett Power Plant Site and sequestration site (see Table 6.2-4), which is well beyond the 62-mile (100-kilometer) distance required to consider impacts to Class I areas under the PSD regulations. All other clean air regions are designated Class II areas, with moderate pollution increases allowed (FWS, 2007). The proposed Jewett Power Plant Site and sequestration site are located in Class II areas.

Table 6.2-4. Nearest Class I Areas to Proposed Jewett Power Plant Site

Class I Area/Location	Distance (miles)	Distance (kilometers)	Direction
Caney Creek Wilderness Area, Arkansas	240	386.2	NE
Wichita Mountains Wilderness Area, Oklahoma	265	426.5	NE

Source: FG Alliance, 2006c.

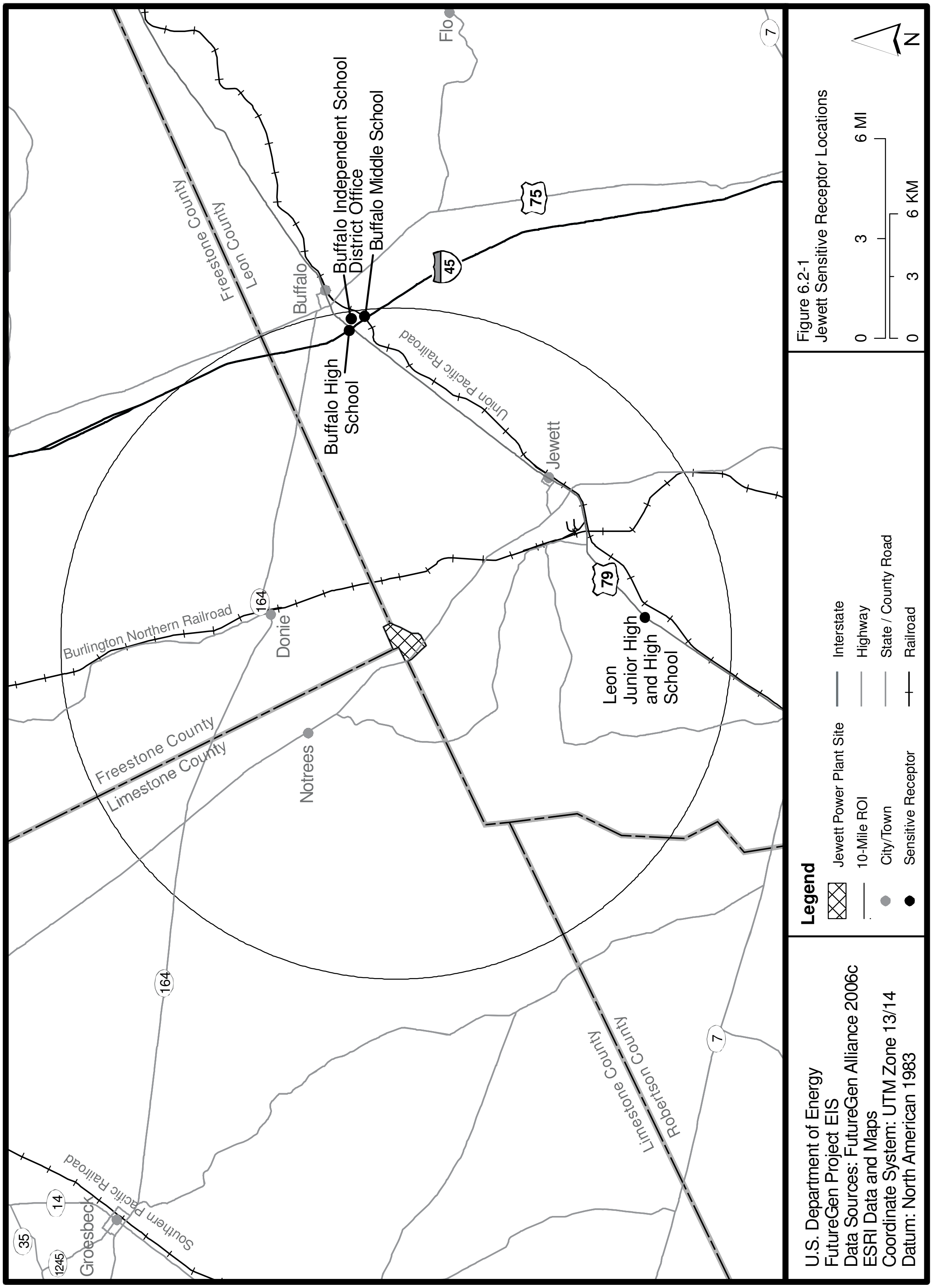

Figure 6.2-1
Jewett Sensitive Receptor Locations

6.2.2.4 Air Quality Management Plans

The CAA requires states to develop federally approved regulatory programs, called State Implementation Plans (SIPs), for meeting the NAAQS throughout the state. These plans aim to limit emissions from sources as necessary to achieve and maintain compliance. In part, SIPs focus on new major stationary sources and modifications to existing major stationary sources. A state's New Source Review (NSR)/PSD review program is defined and codified in its SIP. The Texas SIP is available from the TCEQ.

The FutureGen Project would be required to undertake the NSR/PSD permit application process after a host site is selected. State and local governmental officials contacted during the development of this EIS and the supporting Environmental Information Volume (EIV) indicate that there are no local air quality management plans currently in existence for the ROI (FG Alliance, 2006c). Additionally, these officials have no knowledge of specific local needs or concerns for air quality management at the proposed Jewett Power Plant Site and sequestration site.

6.2.3 IMPACTS

6.2.3.1 Construction Impacts

Construction at the proposed power plant site, sequestration site, utility corridors, and transportation corridors would result in localized increases in ambient concentrations of SO_2, NO_X, CO, VOCs, and PM. These emissions would result from the use of construction equipment and vehicles including trucks, bulldozers, excavators, backhoes, loaders, dump trucks, forklifts, pumps, and generators. In addition, fugitive dust emissions (i.e., PM emissions) would occur from various construction-related activities, including earth moving and grading, material handling and storage, and vehicles traveling over dirt and gravel areas.

Given the size of the proposed site and the short duration of the construction period, potential impacts would be localized and temporary in nature. Construction impacts would be minimized through the use of best management practices (BMPs), such as wetting the soil surfaces, covering trucks and stored materials with tarps to reduce windborne dust, and using properly maintained equipment (see Section 3.4).

Power Plant Site

DOE assumed that up to 200 acres (81 hectares) of the proposed 400-acre (162-hectare) site would be directly affected for the purposes of the air impact analysis. DOE estimates that construction of the proposed Jewett Power Plant would take 44 months. PM concentrations would be localized because of the relatively rapid settling of larger dust particles and impacts to off-site receptors would be temporary. In addition, PM emissions would decrease with the total amount of land disturbed, as PM emissions were calculated on the basis of site acreage. Impacts of the SO_2, NO_X, CO, and VOC emissions from vehicular sources would be temporary in nature and could cause minor to moderate short-term degradation of local air quality. The air pollutant emissions would be minimized through the use of BMPs, such as limiting the amount of vehicle trips, wetting the soil surfaces, covering trucks, limiting vehicle idling, and properly maintaining equipment.

Sequestration Site

While the proposed sequestration site would occur on two properties consisting of approximately 1,550 acres (626 hectares) (FG Alliance, 2006c), only a very small fraction (10 acres [4 hectares]) of the land area would be disturbed by either exploratory investigations (e.g., geophysical surveys) or construction of the sequestration facilities. Construction-related impacts on air quality at the proposed sequestration site would be limited to preparation of well drilling sites and the drilling of wells, as discussed in Chapter 2. Exploratory wells would be installed to sample and test the underground reservoir systems, and injection wells and monitoring wells would be installed to inject CO_2 and monitor its fate. Site preparation and construction activities would involve grading and surface preparation by earth-moving equipment that would result in localized fugitive dust air emissions during construction. Impacts would be localized and temporary in nature and could cause minor to moderate short-term degradation of air quality in the areas where construction is taking place.

Utility Corridors

The proposed utility corridors could include a natural gas pipeline, process water pipeline, potable water pipeline, sanitary wastewater pipeline, and electric transmission line. Construction of the utility corridors would require less acreage, use less equipment, and take less time than the construction of the proposed power plant. The duration of utility corridor construction would range from one week for the process water pipeline to 45 weeks for the other pipelines. The emissions from construction would include SO_2, NO_X, PM, CO, and VOCs. Impacts from emissions of these pollutants would be localized and temporary in nature and could cause minor to moderate short-term degradation of air quality in the areas where construction is taking place.

Transportation Corridors

Access to the proposed Jewett Power Plant Site would be primarily via FM 39, which intersects U.S. Highway (US) 79 and State Highway (SH) 164 within 10 miles (16.1 kilometers) of the site boundary. Additionally, the Burlington Northern Santa Fe Railroad runs along the northeastern border of the proposed Jewett Power Plant Site. Delivery to and from the proposed site could be accomplished by either railway or roadway; therefore, construction of additional roadways or railways would not be required, and no impact would be expected. Travel on existing roadways during construction of the proposed facility and associated corridors are discussed above.

6.2.3.2 Operational Impacts

Power Plant Site

Sources of Air Pollution

Primary sources of air emissions associated with the FutureGen Project would be the combustion turbine, flare, gasifier preheat, cooling towers, and sulfur recovery system (see Figure 2-18). DOE and the Alliance have estimated the maximum potential emissions that would be expected (see Table 6.2-1) using data from equipment typical of an IGCC power plant. However, because the FutureGen Project is in the early stages of design, specific engineering and technical information on the equipment that would ultimately be used is not available. Other sources of air emissions could include mobile sources such as plant vehicular traffic and personnel vehicles, which would be equipped with standard pollution-control devices to minimize emissions.

Local traffic within the proposed power plant site would be expected to emit small amounts of criteria pollutants. In addition, coal delivery trains (five trains per week) would emit a small amount of criteria pollutants from the train exhaust, and potentially PM during coal unloading and handling. However, coal handling emissions are not expected to appreciably change air quality because the emissions would be reduced by minimizing points of transfer of the material, enclosing conveyors and loading areas, and installing control devices such as baghouses and wetting systems.

Clean Air Act General Conformity Rule

Section 176(c)(1) of the Clean Air Act requires that federal actions conform to applicable SIPs for achieving and maintaining the NAAQS for the criteria air pollutants. In 1993, EPA promulgated a rule titled “Determining Conformity of General Federal Actions to State or Federal Implementation Plans,” codified at 40 CFR Parts 6, 51, and 93. The rule is intended to ensure that criteria air pollutant emissions and their precursors (e.g., VOCs and NO_X) are specifically identified and accounted for in the attainment or maintenance demonstration contained in a SIP. The conformity rule applies to proposed federal actions that would cause emissions of criteria air pollutants above certain levels in locations designated as non-attainment or maintenance areas for the emitted pollutants. Under the rule, an agency must engage in a conformity review process and, depending on the outcome of that review, conduct a conformity determination.

DOE conducted a conformity review to assess whether a conformity determination (40 CFR Part 93) is needed for the proposed FutureGen Project. As discussed in Section 6.2.2.1, Leon, Freestone, Limestone, and Anderson counties are in attainment or unclassified with the NAAQS for all pollutants. Additionally, the counties are not designated as a maintenance area. Consequently, no conformity determination is needed (see Section 6.2.2.4).

Criteria Pollutant Emissions

DOE conducted refined modeling using AERMOD. Table 6.2-5 presents the results of the AERMOD modeling for the operational phase of the proposed Jewett Power Plant. Limited amounts of background air concentration data for the Jewett area were available for use in this EIS. For all pollutants, DOE used background data from monitors that were outside the ROI but within attainment areas to represent ambient concentrations for those pollutants. To determine representative background data for both PM_{10} and $PM_{2.5}$ 24-hour and annual averaging periods, DOE took the average of the second-highest monitored data over a period of 3 years (2003 to 2005). For all other pollutants and corresponding averaging periods, the highest of the second-highest values of each year for the period of 3 years (2003 to 2005) was used (see Appendix E).

Table 6.2-5 shows that concentrations of pollutants during the operational phase combined with background concentrations would be below their respective NAAQS during normal operation and plant upset. Additionally, the proposed FutureGen Project would not exceed the Class II PSD allowable increments; however, short-term 3-hour and 24-hour SO_2 concentrations could approach Class II PSD increment limits during plant upset from emissions associated with unplanned restart events. These unplanned restart emissions of SO_2 would typically be higher than steady-state SO_2 emissions, because syngas would be directly flared without the benefit of the sulfur recovery unit (see Appendix E). The probabilities of the proposed power plant exceeding the 3-hour and 24-hour SO_2 Class II PSD increments at the proposed Jewett Power Plant Site during periods of plant upset are 1.7 and 0.2 percent, respectively, and zero percent during normal operating scenarios. Maximum concentrations of the pollutants would be limited to a radius of less than 1.4 miles (2.3 kilometers) from the center of the proposed Jewett Power Plant Site. Currently, there are no residences within 10 miles (16.1 kilometers) of the proposed power plant site; however, there are other sensitive receptors located within the 10-mile radius. These sensitive receptors would be impacted.

Table 6.2-5. Comparison of Maximum Concentration Increases with NAAQS and PSD Increments

Pollutant	Maximum Concentration FutureGen Project Alone[1] (µg/m³)	Maximum Concentration FutureGen Project + Background (µg/m³)	NAAQS (µg/m³)	Class II PSD Increments (µg/m³)	PSD Increment Consumed by FutureGen Project (percent)	Distance of Maximum Concentration (miles [kilometers])
SO_2 (normal operating scenario)[2]						
3-hour	0.82	34.85	1,300	512	0.16	0.58 (0.93)
24-hour	0.42	13.51	365	91	0.46	1.32 (2.12)
SO_2 (upset scenario)[3]						
3-hour	511.91	545.94	1,300	512	99.98	0.58 (0.9)
24-hour	89.50	102.59	365	91	98.35	0.58 (0.9)
SO_2 Annual [4]	0.48	3.10	80	20	2.42	1.37 (2.2)
NO_2[4, 5]						
Annual	0.67	27.01	100	25	2.70	1.37 (2.2)
PM/PM_{10}[4, 6]						
24-hour	0.83	55.83	150	30	2.76	1.32 (2.1)
Annual	0.10	26.10	50	17	0.58	1.37 (2.2)
PM/$PM_{2.5}$[4, 6]						
24-hour	0.83	30.16	35	n/a	n/a	1.32 (2.1)
Annual	0.10	13.80	15	n/a	n/a	1.37 (2.2)
CO[7]						
1-hour	10.45	4,018.62	40,000	n/a	n/a	0.89 (1.4)
8-hour	7.88	1,954.70	10,000	n/a	n/a	1.27 (2.0)

[1] Value based on site-specific meteorological and terrain data. Except for the 3-hour and 24-hour SO_2 during the upset scenario, the highest maximum predicted concentrations are provided for all pollutants and corresponding averaging times, based on the worst-case emissions rates, meteorological data, and terrain data. For the 3-hour SO_2 averaging time, the 618th highest maximum predicted concentration is provided. Although the highest maximum three-hour SO_2 concentration could exceed the PSD increment during the upset scenario, the 3-hour increment would not be exceeded at least 98.34 percent of the time. For the 24-hour SO_2 averaging time during the upset scenario, the 88th highest maximum predicted concentration is provided. Although the highest maximum 24-hour SO_2 concentration could exceed the PSD increment during the upset scenario, the 24-hour increment would not be exceeded at least 99.8 percent of the time. The highest maximum predicted concentrations for the other pollutants and corresponding averaging times would not be expected to exceed the PSD Class II increment at any time.
[2] The normal operating scenario is based on steady-state emissions and is a period when the plant is operating without flaring, sudden restarts, or other upset conditions (see Appendix E).
[3] The upset scenario is based on unplanned restart emissions and is a period when a serious malfunction of any part of the IGCC process train usually results in a sudden shutdown of the combined-cycle units gas turbine and other plant components (see Appendix E).
[4] Annual impacts are based on maximum annual emissions (see Appendix E) over 7,446 hours per year.
[5] There are no short-term NAAQS for NO_2.
[6] There are no unplanned restart emissions of PM_{10} and $PM_{2.5}$ pollutants; therefore, short-term impacts (24-hour) are based on steady-state emissions.
[7] Although there are unplanned restart emissions of CO pollutants, the short-term impacts (1-hour and 8-hour) are based on steady-state emissions because steady-state CO emissions are larger than unplanned restart CO emissions.
n/a = not applicable; µg/m³ = micrograms per cubic meter.
Source: AERMOD modeling result (see Appendix E).

Hazardous Air Pollutants

HAP emissions from the FutureGen Project were estimated based on the Orlando Project, a recent IGCC power plant that was determined to provide the best available surrogate data (DOE, 2007). DOE scaled the Orlando Project data based on relative emission rates of VOCs and PM to produce more appropriate estimates of emission rates for the FutureGen Project. However, only emissions from the gas turbine were considered to account for differences between the Orlando design and the FutureGen Project. These differences include the FutureGen Project's use of oxygen (O_2) in the gasifier instead of air, the use of a catalytic shift reactor to convert CO to CO_2, and CO_2 capture and sequestration features.

Predicted HAP emissions are presented in Table 6.2-6. This data indicates that the FutureGen Project would not emit any individual HAP above the 10-tpy (9.1-mpty) major source threshold. Additionally, at 0.32 tpy (0.3 mtpy) of combined HAPs, the proposed FutureGen Project would not be a major source of HAPs as defined under the ***PSD***. Health hazards and risks associated with these HAP emissions and other air toxins are discussed in Section 6.17.

Table 6.2-6. Annual Hazardous Air Pollutant Emissions[1]

Chemical Compound	Combustion Turbine Emissions	
	tpy	mtpy
2-Methylnaphthalene	7.41E-04	6.72E-04
Acenaphthyalene	5.36E-05	4.86E-05
Acetaldehyde	3.72E-03	3.37E-03
Antimony[2]	2.08E-02	1.89E-02
Arsenic[2]	1.09E-02	9.93E-03
Benzaldehyde	5.99E-03	5.44E-03
Benzene	1.00E-02	9.09E-03
Benzo(a)anthracene	4.77E-06	4.32E-06
Benzo(e)pyrene	1.14E-05	1.03E-05
Benzo(g,h,i)perylene	1.96E-05	1.78E-05
Beryllium[2]	4.69E-04	4.26E-04
Cadmium[2]	1.51E-02	1.37E-02
Carbon Disulfide	9.27E-02	8.41E-02
Chromium[2, 3]	1.41E-02	1.28E-02
Cobalt[2]	2.97E-03	2.69E-03
Formaldehyde	6.89E-02	6.25E-02
Lead[2]	1.51E-02	1.37E-02
Manganese[2]	1.62E-02	1.47E-02
Mercury[2]	4.73E-03	4.29E-03
Naphthalene	1.10E-03	9.96E-04
Nickel	2.03E-02	1.84E-02
Selenium	1.51E-02	1.37E-02
Toluene	1.53E-03	1.39E-03
TOTAL	**3.21E-01**	**2.91E-01**

[1] Emission rates scaled by the ratio of VOC or PM emissions from Orlando Gasification Project EIS to the FutureGen Project. Orlando Project's VOC emissions were multiplied by a factor of 0.2727, based on 30 tpy (27.2 mtpy) VOC for the FutureGen Project divided by 110 tpy (99.8 mtpy) VOC for the Orlando Project. The Orlando Project's PM emissions were multiplied by a factor of 0.6894, based on 111 tpy (100.7 mtpy) PM for the FutureGen Project divided by 161 tpy (146.1 mtpy) PM for the Orlando Project.
[2] Compounds which are considered to be PM are in bold text.
[3] Conservatively assumed all chromium to be hexavalent.
tpy=tons per year; mtpy=metric tons per year.
Source: DOE, 2007.

Mercury

CAMR ***establishes "standards of performance" limiting mercury emissions from new and existing coal-fired power plants and creates a market-based cap-and-trade program that reduces nationwide utility emissions of mercury in two distinct phases. CAMR applies to units*** that produce more than 25-MW equivalent ***electrical*** output and that would sell ***more than one-third of their potential*** electric***al output***. ***Under CAMR, each State must submit a plan whereby the State will meet its mercury emissions budget under the nationwide cap; a State plan may deviate from the model rule developed by EPA but may not exceed its budget.*** Based on 2005 Hg emissions, Texas has exceeded its State Hg cap and will utilize a cap and trade strategy to bring existing and new sources under ***the NSPS*** limit (TCEQ, 2006). ***The FutureGen Project would be subject to CAMR because it is a unit that would generate approximately 275 megawatts-electrical (MWe) and would sell more than one-third of its potential electric output. The FutureGen Project would remove over 90 percent of Hg during the syngas cleanup process using activated carbon beds. Upon facility startup, the FutureGen Project would need to comply with the State plan for CAMR, as well as meet the Federal NSPS emission limits. Continuous monitoring for Hg would also be required.*** The AERMOD analysis predicted that a negligible annual concentration of Hg (9.93×10^{-6} micrograms per cubic meter) would ***result*** within 1.37 miles (2.2 kilometers) of the proposed power plant site.

Radionuclides and Radon

Coal is largely composed of organic matter, but some trace elements in coal are naturally radioactive. These radioactive elements include uranium (U), thorium (Th), and their numerous decay products, including radium (Ra) and radon (Rn). During coal processing (e.g., gasification) most of the uranium, thorium and their decay products are released from the original coal matrix and are distributed between the gas phase and the ash product. Almost all radon gas present in feed coal is transferred to the gas phase. In contrast, less volatile elements such as thorium, uranium, and the majority of their decay products are almost entirely retained in the solid ash or slag.

The concentration of uranium and thorium in coal is low. Analyses of Eastern and Western coals show that in the majority of samples, concentrations of uranium and thorium fall in the range from slightly below 1 to 4 parts per million (ppm). Similar uranium and thorium concentrations are found in a variety of common rocks and soils. For example, average thorium concentration in the earth's crust is approximately 10 ppm. Based on standards for hazardous pollutants, EPA determined that current levels of radionuclide emissions (both parent elements and various decay products) from coal-fired boilers represent a level of risk that protects the public health with an ample margin of safety. Therefore, since the FutureGen plant objective is to achieve near-zero emissions and will have greater particulate control, the risk from air emissions for the FutureGen plant is projected to be less than the plants represented in the EPA study.

The fate and transport of radionuclides in a coal combustion power plant is reasonably well understood, and most radionuclides (with the exception of radon, see below) will partition to the slag or ash. However, limited research to date has been conducted on gasification facilities. DOE sponsored testing and measurement of a number of trace substances, including radionuclides, at the Louisiana Gasification Technology, Inc., (LGTI) facility located within the Dow Chemical complex in Plaquemine, Louisiana. The objective was to characterize such emissions from an integrated gasification combined cycle power plant. Sampling and chemical analyses included samples from inlet streams (e.g., coal, makeup water, ambient air conditions) and outlet streams leaving the plant (e.g., slag, water, exhaust streams). Limited data indicates that radionuclides behave in a similar manner to combustion facilities but the available data is insufficient to draw significant conclusions. As mentioned previously, FutureGen will have extremely high particulate control compared to conventional coal plants, a requirement for reliable operation of combustion turbines. In addition,

FutureGen will have advanced highly efficient control equipment for removal of other syngas contaminants including mercury, sulfur and CO_2 beyond those that were included in the LGTI facility. These additional emission control devices provide added locations where radionuclides may be trapped, resulting in substantially lower emissions compared to existing facilities that use conventional technologies.

Radon is a naturally occurring, inert gas that is formed from normal radioactive decay processes. Radon in the atmosphere comes largely from the natural release of radon from rock *and soil* ***close to the*** *Earth's* ***surface. Radon in coal will be present in the gas phase (e.g., gas bubbles within the coal). The source of the radon is from the decay over time of uranium 235 and 238 or thorium 232 that would have occurred in the coal seam. Some of the radon gas in the coal would be released during mining and coal preparation prior to arriving at the FutureGen plant. The radon released during the gasification process would be present in the syngas product leaving the gasifier. Various syngas cleaning and conditioning processes will be included in the FutureGen plant, likely including water and solvent scrubbing processes as well as absorbent/adsorbent systems. Since radon is soluble in water it is possible that a significant portion of the radon will be transferred to the water stream. Some radon will likely pass through the various scrubbing operations and will be emitted through the stack gas. Technology is currently available and commercially used to remove radon from water (e.g., granular activated carbon, aeration processes) and waste water treatment facilities will be designed to provide suitable control of regulated pollutants.***

DOE recognizes that radionuclides are present at detectable levels in coal throughout the U.S. While EPA has indicated that the risk of exposure from emissions from utilities is substantially lower than risks from background radiation, DOE acknowledges that there are research gaps related to the ultimate fate of radionuclides in advanced coal technologies. Characterization and monitoring of gaseous and solid effluents from the facility will be consistent with necessary requirements to ensure compliance with required permits. As a research facility aimed to provide the pathway of achieving coal-based energy generation with zero emissions, FutureGen is a likely candidate location for advancing the understanding of the ultimate fate of trace substances in coal, including the ultimate fate of radionuclides.

Greenhouse Gases

GHGs include water vapor, CO_2, methane, NO_X, O_3, and several chlorofluorocarbons. Water vapor is a naturally occurring GHG and accounts for the largest percentage of the greenhouse effect. Next to water vapor, CO_2 is the second-most abundant GHG. Uncontrolled CO_2 emissions from power plants are a function of the energy output of the plants, the feedstock consumed and the power plants' net efficiency at converting the energy in the feedstock into other forms of energy (e.g., electricity, useable heat, and hydrogen gas). Because CO_2 is relatively stable in the atmosphere and essentially uniformly mixed throughout the troposphere and stratosphere, the climatic impact of CO_2 emissions does not depend upon the CO_2 source location on the earth (DOE, 2006a). Although regulatory agencies are taking actions to address GHG effects, there are currently no Texas or federal standards or regulations limiting CO_2 emissions and concentrations in the ambient air.

The proposed FutureGen Project would produce electricity and hydrogen fuel while emitting CO_2. DOE estimates that up to 0.28 million tons (0.25 million metric tons [MMT]) per year of CO_2 would be released into the atmosphere. A goal of the FutureGen Project is to capture and permanently sequester at least 90 percent of the CO_2 generated by the proposed power plant at a rate of 1.1 to 2.8 million tons (1.0 to 2.5 MMT) per year. By sequestering the CO_2 in geologic formations, the FutureGen Project aims to prove one technological option that could virtually eliminate future CO_2 emissions from similar coal-based power plants.

DOE's Energy Information Administration (EIA) report (DOE, 2006a) indicates that U.S. CO_2 emissions have grown by an average of 1.2 percent annually since 1990 and energy-related CO_2 emissions constitute as much as 83 percent of the total annual CO_2 emissions. DOE reviewed EPA's Emissions and Generation Resource Integrated Database (eGRID) to gain an understanding of the scale of the estimated CO_2 emissions from the proposed FutureGen Project compared to existing coal-fueled plants (EPA, 2006b). eGRID provides information on the air quality indicators for almost all of the electric power generated in the U.S.

The most recent data that can be accessed electronically is for the year 2000. A review of the database yielded the following information:

- In 2000, CO_2 emissions from all coal-fueled plants in Texas equaled 152.7 million tons (138.6 MMT). The average emissions rate of these coal plants was 2,292 pounds (1,039 kilograms) per megawatt-hour.
- Based on the average CO_2 emissions rates of nine representative coal plants in the size range of 153 to 508 MW, a conventional 275-MW coal-fueled power plant would emit 2.17 million tons (2.0 MMT) per year at an 85 percent capacity factor. This is in the same range as the estimated amount of CO_2 (1.1 to 2.8 million tons [1.0 to 2.5 MMT] per year) that would be sequestered by the proposed FutureGen Project.

Carbon capture and sequestration, if employed widely throughout the U.S in future power plants or retrofitted existing power plants, could help reduce and possibly reverse the growth in national annual CO_2 emissions.

*Acid Rain **Program and Clean Air Interstate Rule** Requirements*

Acid rain or acid deposition can occur when acid precursors (such as SO_2 and NO_X) are released into the atmosphere, and they react with O_2 and water to form acids (EPA, 2007). Acid rain can cause soil degradation; increase acidity of surface water bodies; and reduce growth, injure, or even cause death of forests and aquatic habitats. The Acid Rain Program, established under ***CAA*** Title IV, ***generally*** requires electric generating units ***producing electricity for sale*** to obtain a Phase II Acid Rain Permit and meet the objectives of the program, which are achieved through a system of marketable ***SO_2*** allowances ***and through NO_X emission limitations***. The FutureGen Project would be required to obtain a Phase II Acid Rain Permit and would operate in a manner that is consistent with EPA's overall efforts to reduce emissions of acid precursors. Continuous emissions monitoring for SO_2, NO_X, and CO_2, as well as ***for*** volumetric gas flow and opacity, is ***generally required under*** the acid rain regulations, which ***also*** include ***other*** monitoring, recordkeeping, and reporting ***requirements***. ***CAIR, established under CAA section 110, expanded on the Acid Rain Program for 28 States in the eastern United States by lowering the cap for SO_2. CAIR also established a NO_X cap-and-trade program that broadens the geographic scope of the NO_X Budget Trading Program (NO_X SIP Call) and tightens the cap. CAIR has similar requirements for obtaining allowances and for monitoring, recordkeeping, and reporting.*** Upon facility startup, the FutureGen Project would need to ***hold*** SO_2 ***and NO_X emission*** allowances to ***cover*** actual SO_2 ***and NO_X*** emissions from the facility.

Odors

Operation of the FutureGen Project may cause noticeable odors. The chemical components that could cause noticeable odors are hydrogen sulfide (H_2S) and ammonia (NH_3). H_2S is formed during the gasification of coal containing sulfur. The FutureGen Project would use an acid gas removal system that would potentially remove 99 percent of the sulfur in the syngas stream, thereby reducing the amount of H_2S emitted and reducing the impact from H_2S odors. For the FutureGen Project, the fuel stock would be blown into the gasifier using O_2; therefore, the NH_3 in the syngas would be formed from fuel bound nitrogen. Additionally, NH_3 would used in a Selective Catalytic Reduction (SCR) system, a potential component of the FutureGen Project, which controls NO_X emissions. While the current FutureGen Project design configurations include an SCR system, current research activities sponsored under the DOE Fossil Energy Turbine Program are investigating technologies that can achieve the NO_X emissions goals through combustion modifications only, thereby eliminating the need for post-combustion SCR (DOE, 2006b). The Alliance estimates that approximately 1,333 tons (1,209 metric tons) of NH_3 per year would be consumed in the FutureGen SCR process (FG Alliance, 2006e).

Both gases would normally only be emitted as small quantities of fugitive emissions (e.g., through valve or pump packing); however, if an accidental large release were to occur, such as a pipe rupture in the Claus Unit (the sulfur recovery unit) or from on-site NH_3 storage, a substantial volume of odor would be noticeable beyond the plant boundary. Other odors could be emitted from activities such as equipment maintenance, coal storage, and coal handling; however, these potential odors should be limited to the immediate site area and should not affect off-site areas. Texas regulates H_2S odors in the ambient air (i.e., beyond the fence line) under nuisance laws. There are no odor regulations for NH_3. Depending on the wind direction, even small volumes of H_2S and NH_3 odor could be a nuisance for receptors near the proposed Jewett Power Plant Site.

Local Plume Visibility, Shadowing, Fogging, and Water Deposition

The proposed Jewett Power Plant would have two main sources of water vapor plumes: the gas turbine exhaust stack and the cooling towers. The height of the cooling tower is typically less than the height of the gas turbine exhaust stack, which for the FutureGen Project is estimated to be 250 feet (76.2 meters) (FG Alliance, 2006e). Because of a reduced height, the cooling tower presents a greater concern than the gas turbine exhaust stack for impacts such as ground-level fogging, water deposition and solids deposition (including precipitates). Cooling tower "fogging" occurs when the condensed water vapor plume comes in contact with the ground for short time periods near the tower. ***Evaporated water would be pure water, although water droplets carried with the exhaust air (called drift) would have the same concentration of impurities as the water entering and circulating through the tower. Water treatment additives could contain anti-corrosion, anti-scaling, anti-fouling and biocidal additives which can create emissions of VOCs, particulate matter, and toxic compounds. The drift is not expected to cause excessive pitting or corrosion of metal on nearby structures or equipment due to the relatively small amount of water released and the presence of trace amounts of anti-corrosion additives. Similarly, the treatment additives are not expected to cause noticeable adverse impacts to local biota due to the very small amounts released.*** Potential deposition of solids would occur because the Jewett Site proposes to use groundwater that is generally highly saline (see Section 6.6.2.1). Effects from vapor plumes and deposition, would be most pronounced within 300 feet (91.4 meters) of the vapor source and would decrease rapidly with distance from the source. ***However, as a best management practice, the drift rate and associated deposition of solids could be reduced by employing baffle-like devices, called drift eliminators.*** Both cooling towers and the gas turbine exhaust plume may cause some concern for shadowing and aesthetics. Plume shadowing is generally a concern only when considering its effect on agriculture, which, due to the attenuation of sunlight by the plume's shadow, may reduce yield.

At the proposed Jewett Power Plant Site, nearby residences or agriculture could be impacted by fogging, water deposition, icing, or solid deposition under rare meteorological events; however, the impacts would be minimal. The greatest concern would be for traffic hazards created on FM-39, which borders the southwest side of the proposed power plant property. Because the proposed Jewett Site has 400 acres (162 hectares) and the FutureGen Project requires 60 acres (24 hectares), it is unlikely that the boundary of the power plant would be located within 300 feet (91.4 meters) of FM-39. If the location of the cooling tower and stack are more than 300 feet (91.4 meters) from the road, fog from the plant would dissipate and deposition of solids on the roads should not occur. Overall, solar loss, fogging, icing, or salt deposition from the proposed Jewett Power Plant would not interfere with quality of life in the area.

Effects of Economic Growth

Any air quality impacts due to residential growth would be in the form of automobile and residential (fuel combustion) emissions that would be dispersed over a large area. Commercial growth would be expected to occur at a gradual rate in the future, and any significant new source of emissions would be required to undergo permitting by the TCEQ. Impacts of economic growth on ambient air quality and PSD increments are unknown at this time. As part of the PSD permitting process, a determination of existing background concentrations of pollutants and additional modeling work would be required to estimate the maximum air pollutant concentrations that would be associated with the proposed Jewett Power Plant as a result of future economic growth. Section 6.19, provides detailed discussions of the impacts of economic growth from the FutureGen Project on the local resources.

Effects on Vegetation and Soils

Section 165 of the Clean Air Act requires preconstruction review of major emitting facilities to provide for the prevention of significant deterioration and charges federal managers with an affirmative responsibility to protect the AQRVs of Class I areas. Implementing regulations requires an analysis of the potential impairment to visibility, soils, and vegetation. Subsequently, EPA developed "A Screening Procedure for the Impacts of Air Pollution Sources on Plants, Soils, and Animals," which specifies the air pollutant screening concentrations for which adverse effects may occur for various vegetation species and soils, depending on their sensitivity to pollutants (EPA, 1980). While the Jewett Power Plant Site is more than 62 miles (100 kilometers) from a Class I area, there may be sensitive vegetation that could be affected by the plant's air emissions. Therefore, DOE compared the power plant's predicted maximum air pollutant emissions with the EPA screening concentrations (Table 6.2-7). Based on this comparison, the power plant's emissions would be well below applicable screening concentrations. Emissions also would be well below the secondary NAAQS criteria, which are established to prevent unacceptable effects to crops and vegetation, buildings and property, and ecosystems.

Table 6.2-7. Screening Analysis for Effects on Vegetation and Soils

Pollutant	Averaging Period[1]	Maximum Total Concentration[2] ($\mu g/m^3$)	Screening Concentrations[3] ($\mu g/m^3$)	Secondary NAAQS ($\mu g/m^3$)
SO_2	3-hour	545.94	786	1,300
NO_2	Annual	27.01	94	100

[1] Maximum concentration for shortest averaging period available.
[2] Maximum concentration including background data (see Table 6.2-5).
[3] The most conservative values were utilized, based on the highest vegetation sensitivity category.
$\mu g/m^3$ = micrograms per cubic meter.
Source: EPA, 1980.

Effects on Animals

The secondary NAAQS were established to set limits to protect public welfare, including protection against harm to animals. The maximum predicted concentrations from the FutureGen Project estimated from the upperbound emissions of the FutureGen Project's estimate of maximum air emissions, in addition to the ambient background concentration, are below the secondary NAAQS for all pollutants.

Sequestration Site

The proposed CO_2 sequestration reservoir would be within bedrock layers located approximately 1 mile (1.6 kilometers) beneath the ground surface, far below the soil zone, ***groundwater table***, and overlying unsaturated zone (see Section 6.5 and Chapter 2). Because co-sequestration of H_2S and CO_2 is being considered as part of research and development activities for the FutureGen Project, minor air emissions of H_2S and CO_2 would occur during routine operations over the lifetime of the proposed injection period, which DOE expects to be between 20 to 30 years, and possibly up to 50 years. Sources of emissions during sequestration site operations could include:

- Injection wells, monitoring wells, and other wells; and
- Aboveground valves, piping, and well heads that comprise the transmission system.

Injection Wells, Monitoring Wells, and Other Wells

Wells provide the greatest opportunity for the escape of sequestered fluids. The injection well would extend into a target injection zone, with steel pipe inserted its full length and cemented into the bore hole to prevent upward escape of sequestered fluid around the outside of the pipe. Within the steel casing, tubing is installed from the well head down to the top of the injection zone, with the annular space sealed against the casing with a packer. The annular space is filled with heavy liquid, such as brine, to help control any accidental leakage into the annular space. This tubing could be removed and replaced should it become corroded or damaged over time. The technology is standard for constructing a well of this type and no measurable fugitive emissions from the well would be expected. Monitoring wells would be constructed in a similar manner as the injection wells, so they would be secure and could also be monitored for leaks and be repaired as needed. There should be no contact by CO_2 with the soils. The sequestration reservoir would be tested for assurance that no leak paths exist prior to project operations. Pre-existing oil wells that are not related to the FutureGen Project present a greater risk of leakage. If Jewett is selected to host the FutureGen Project, DOE anticipates that some means of identifying the locations of pre-existing wells over the plume and monitoring these wells for leakage would be employed at levels commensurate with the risks posed by the pre-existing wells. Wells that provide leakage points would be repaired or plugged to prevent leakage and emissions. All exploratory wells would be properly plugged with concrete and abandoned before operation of the sequestration facility if they are not used as injection wells or monitoring wells, preventing potential fugitive emissions from the sequestered CO_2.

Aboveground Valves, Piping, and Well Heads

The supercritical CO_2 that would be piped from the plant to the injection wells would enter each well through a series of valves attached to the underground steel pipe to ensure proper direction and control of flow. These valves would be above ground and easily accessible to workers for controlling well operation and conducting well maintenance. There would typically be four valves with flanged fittings for each well. Fugitive emissions from each valve were estimated based on a California South Coast Air Quality Management District (SCAQMD, 2003) valve emission factor of 0.0013 pound (0.6 gram) per hour for non-methane organic compounds. In addition to the expected fugitive emissions typical of gate valves, periodic well inspections, testing, and maintenance would be another source of emissions. The well valves would be periodically manipulated to allow insertion of inspection or survey tools to test the integrity of the system or to repair or replace system components. During each of those instances, some amount of CO_2 gas would be vented to the atmosphere.

The annual emissions estimate is based on the two injection wells required, accounting for the tubing volume and the number of evacuations that would occur each time a valve is opened. DOE estimates annual emissions of approximately 90.4 tons (82.0 metric tons) of CO_2. A number of tracers would also be used to track the fate and transport of the injected CO_2. Descriptions of these compounds are provided in Section 6.16. Fugitive emissions from valves, piping, and well heads may also contain very minute amounts of these tracers.

Utility Corridors

There are no planned operational activities along the proposed utility corridors that would cause air emissions impacts. Routine maintenance along the corridors would not result in fugitive emissions. However, if repairs were required and an underground line had to be excavated, there would be localized and temporary soil dust releases during the excavation process, which would be minimized through BMPs.

Transportation Corridors

During operation of the power plant, transportation-related air emissions would be produced from train and truck shipments to and from the plant and also from employee automobiles. Major pollutants emitted from automobiles, trucks, and trains include hydrocarbons (HC), NO_X, CO, PM, and CO_2. Trucks emit more HC and CO than trains on a brake horsepower per hour basis although they emit less NO_x and PM on the same basis. The higher values for HC and CO are caused by the differences in driving cycle—the truck driving cycle is much more dynamic than that of a train, which has more constant speed operations (Taylor, 2001). The FutureGen Project would aim to utilize train shipments for materials and waste to the greatest extent possible to increase transportation efficiency and reduce shipping costs but to also minimize related air pollution.

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6.3 CLIMATE AND METEOROLOGY

6.3.1 INTRODUCTION

This section addresses the region's climate and meteorology and the potential impacts on construction and operation of the proposed FutureGen Project.

6.3.1.1 Region of Influence

The ROI for climate and meteorology includes the proposed Jewett Power Plant Site, sequestration site, and the utility and transportation corridors.

6.3.1.2 Method of Analysis

DOE reviewed the Jewett EIV (FG Alliance, 2006c) report to assess the potential impacts of climate and meteorology on the proposed FutureGen Project. Factors identified in this section include normal and extreme temperatures, and severe weather events such as tornadoes and floods. There were no uncertainties identified in relation to climate and meteorology at the proposed Jewett Site.

DOE assessed the potential for impacts based on the following criteria:

- Potential for aspects of the project to fail or cause safety hazards due to temperature variations and extremes; and
- Potential for aspects of the project to fail or cause safety hazards due to a high probability for severe weather events.

6.3.2 AFFECTED ENVIRONMENT

This section describes the east-central Texas region's climate and provides information on climate, meteorology, and severe weather events for Leon, Limestone, Freestone, and Anderson counties.

6.3.2.1 Local and Regional Climate

The **Köppen Climate Classification System** is the most widely used system to classify world climates. Categories are based on the annual and monthly averages of temperature and precipitation. The Köppen System recognizes five major climatic types, and each type is designated by a capital letter (A through E). Additional information about this classification system is available at http://www.blueplanetbiomes.org/climate.htm (Blue Planet Biomes, 2006).

The proposed Jewett Power Plant Site is located at the intersection of Freestone, Leon, and Firestone counties, just north of the town of Jewett in east-central Texas, and about halfway between Dallas and Houston. The proposed sequestration sites are located 33 miles (53.1 kilometers) northeast of the proposed power plant site in Freestone and Anderson counties. This entire region has a mid-latitude, subtropical climate consistent with the Köppen Climate Classification "Cfa." The Köppen Climate Classification System recognizes five major climate types based on annual and monthly temperature and precipitation averages. Each major type is designated by a capital letter A through E. The letter "C" refers to humid, mid-latitude climates where land/water differences play a large part. These climates have warm, dry summers and cool, wet winters. Further subgroups are designated by a second, lowercase letter which distinguishes seasonal temperature and precipitation characteristics. The letter "f" refers to moist climates with adequate precipitation in all months and no dry season. This letter usually accompanies A, C, and D climates. To further denote variations in climate, a third letter was added to the code. The letter "a" refers to hot summers where the warmest month is over 72°F (22°C). These can be found in C and D climates. Maximum precipitation occurs in the spring and fall, and minimum precipitation occurs in the summer. Average annual precipitation is about ***43*** inches (***109.2*** centimeters), and measurable precipitation occurs about 80 days per year. Average annual winter snowfall is 1.4 inches (3.6 centimeters) (FG Alliance, 2006c).

Winters in the region are generally mild with average high and low January temperatures around 56.1°F (13.4°C) and 45.2°F (7.3°C), respectively. On average, the temperature falls below 32°F (0°C) 33 days a year. In the summer, the maximum high temperature is 95.6°F (35.3°C) and the minimum low temperature is 73.0°F (22.8°C). High temperatures reach 90°F (32.2°C) more than 25 times each summer on average, and around 11 times during the spring and fall. Table 6.3-1 summarizes representative temperature, precipitation, and wind speed data.

Table 6.3-1. Seasonal Weather Data

Weather Parameter	Spring	Summer	Fall	Winter
Average Daily Temperature, °F (°C)	71 (21.6)	***(80) (26.6)***	59 (15.0)	52 (11.1)
Average Precipitation, inches (centimeters)	***12.6 (32.0)***	***8.4 (21.3)***	***12.4 (31.5)***	***9.6 (24.4)***
Average Wind Speed, miles per hour (kilometers per hour)	11.6 (18.6)	9.8 (15.7)	10.2 (16.4)	11.7 (18.8)

°F = degrees Fahrenheit; °C = degrees Celsius.
Source: FG Alliance, 2006c.

A wind rose is a graph created to show the directional frequencies of wind. Representative wind rose data for 2005 were presented in Figure 6.3-1. The wind rose is representative of the percent of time that the wind blows at a particular speed and direction. The concentric circles on the wind rose represent percentage of time. The wind rose is based on combined climate data from the Waco Regional Airport and Huntsville Municipal Airport weather stations. As the wind rose indicates, the most common wind directions are from the south and the south-southeast, and from the north to a lesser extent. The average annual wind speed is about 10.8 mph (17.4 kmph).

Average seasonal wind speeds vary from of 11.7 mph (18.8 kmph) in the winter to a low of 9.8 mph (15.7 kmph) in the summer (FG Alliance, 2006c). For the proposed FutureGen Project, the primary use of wind rose data is for evaluating potential hazardous material releases to estimate plume transport times and determine potential population exposure.

The proposed power plant site and sequestration site are located in the east-central region of Texas, which historically experiences a wide spectrum of weather phenomena including cold and hot days, high winds, heavy rainfalls, thunderstorms, localized floods, and tornadoes.

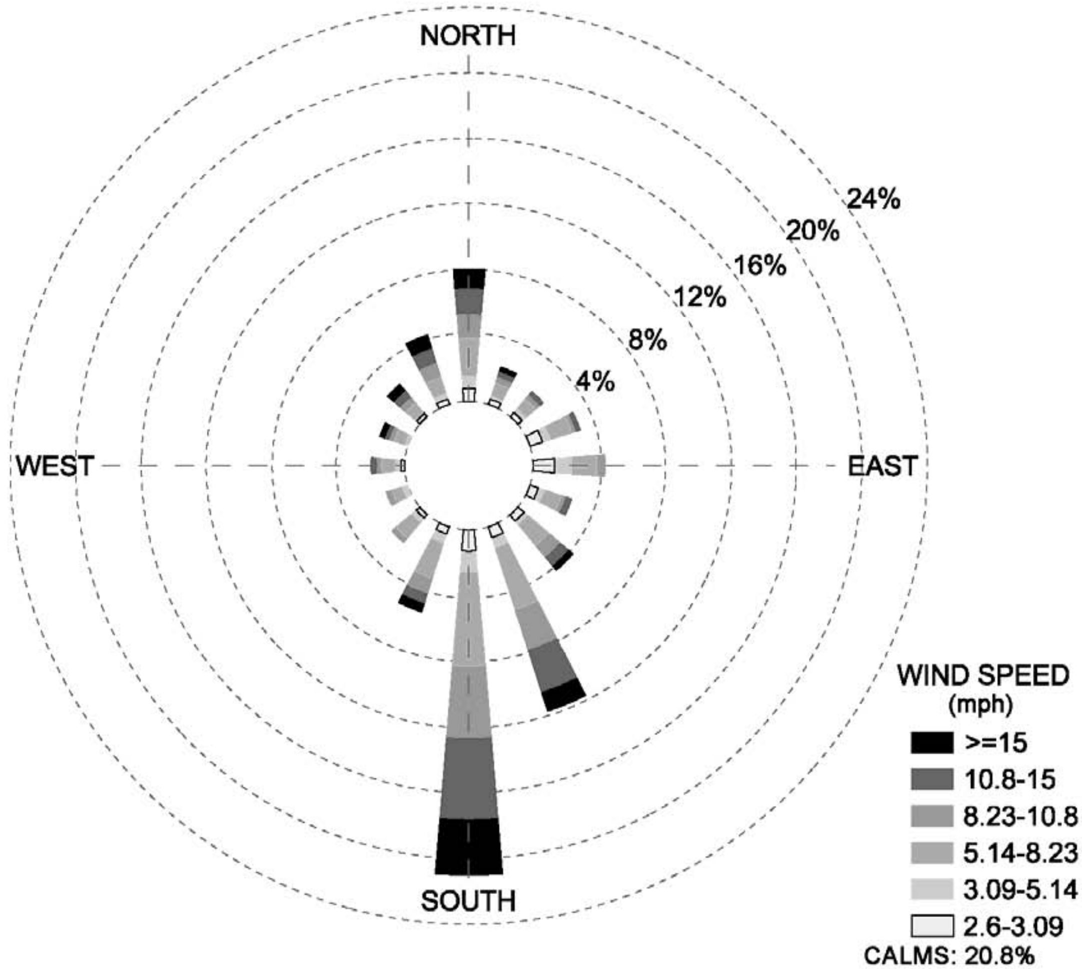

Figure 6.3-1. Wind Rose for the Jewett Region

6.3.2.2 Severe Weather Events

Relevant severe weather events for the ROI include tornadoes, floods, and drought. The proposed project site is located more than 100 miles (161 kilometers) inland from the Gulf Coast. For this reason, coastal hurricanes do not occur within the region and have been excluded from discussion.

> The most common metric for tornado strength is the **Fujita Scale**. There are six categories on this scale. F0 and F1 are considered weak, F2 and F3 are strong, and F4 through F6 are violent. Each category represents a qualitative level of damage and an estimated range of sustained wind speed delivered by the tornado. Additional information about the Fujita Scale is available at http://www.tornadoproject.com/fscale/fscale.htm (The Tornado Project, 1999).

Tornadoes

The National Oceanic Atmospheric Administration (NOAA) documents tornado activity for each Texas county (NOAA, 2006). The Fujita Scale is a standard qualitative metric to characterize tornado intensity based on the damage caused. This scale ranges from F0 (weak) to F6 (violent). From 1950 to ***2007***, ***44*** tornados were reported in the three-county region of the proposed project site (Freestone, Leon, and Limestone counties). Of the ***44*** tornadoes reported, ***25 caused property damage that collectively totaled more than $35 million.*** Table 6.3-2 summarizes the number of various tornadoes reported and how many caused property damage (FG Alliance, 2006c). Collectively, these ***three*** counties span ***2,858*** square miles (***7,402*** square kilometers). ***Based on historical tornado activity within the three counties, there could be 21 F1 or greater tornadoes across all three counties (over 2,858 square miles [7,403 square kilometers]) over the possible 50 year lifespan of the FutureGen Project. For comparison purposes with the other candidate sites, using a nominal county size of 850 square miles (2,202 square kilometers), the tornado frequency would equate to approximately 7 F1 or greater tornadoes over 50 years.***

The sequestration site injection wells would be located in both Freestone and Anderson counties. Tornado data for Freestone County was used to analyze impacts due to the close proximity of the Anderson County wells to the Freestone County boundary.

Table 6.3-2. Regional Tornado Activity, 1950 to 2006

	Freestone, Leon, and Limestone Counties	
Fujita Intensity	**Quantity**	**Caused Property Damage**
F0	*20*	*8*
F1	10	5
F2	*12*	*11*
F3	1	1
F4	1	0
F5	0	0
Total	*44*	*25*

Floods

The proposed power plant site is located outside of the 500-year floodplain. The CO_2 pipeline corridors extend from the Brazos River Basin to the northeast across the Trinity River Basin. There are approximately 30 significant water bodies (creeks and streams) along the proposed CO_2 pipeline corridor. Multiple segments of the CO_2 pipeline corridor and about one-fourth of the land area inside the proposed sequestration site would be within the 100-year floodplain. Portions of the proposed utility corridors and proposed transportation infrastructure corridors would also be within the 100-year floodplain. From 1993 to 2006, 57 flood events were reported in the three-county region of the proposed project site (Freestone, Leon, and Limestone counties). Property damage was reported for only six of these floods, and the maximum damage from any single flood was $50,000. Twenty flood events have been documented in Anderson County since 1994, with minimal damage reported (FG Alliance, 2006c).

Drought

Texas has suffered notable period of drought since the 1930s with extended periods of severe to extreme drought in 1933 to 1935, 1950 to 1957, 1962 to 1967, 1988 to 1990, 1996, and 1998 to 2002. These droughts were more common and widespread in the Rio Grande Basin in the western part of the state. A statewide network of data collection sites, operated by state and federal agencies, has been established to monitor drought conditions. These sites provide real-time climate, steam flow, aquifer, and reservoir information to water management professionals to develop drought mitigation and response plans. Additional information on the State of Texas Drought Preparedness Plan can be found at http://www.txwin.net/DPC/State_Drought_Preparedness_Plan.pdf.

6.3.3 IMPACTS

6.3.3.1 Construction Impacts

Power Plant Site

Severe temperature or weather conditions may temporarily delay construction at the proposed power plant site. Some aspects of construction could not be performed in the rain or snow, or when temperatures are too low, so delays could potentially arise due to unusually cold or wet weather conditions. These conditions could delay material deliveries to and from the construction site. However, it is anticipated that the impacts would be relatively minor and temporary, as the region's climate is relatively mild.

A strong thunderstorm, flood, or tornado could also cause construction delays; however, the probability that these adverse climate conditions would compromise construction schedules would be small. ***The tornado frequency is equivalent to approximately 7 F1 or greater tornadoes over a 50 year period for an area of 850 square miles (2,202 square kilometers). The probability of a tornado greater than F1 intensity across the three counties is approximately 1 every 2 to 3 years and the power plant site represents 0.02 percent of the combined land area of the counties. Therefore, the chance for significant direct and indirect impacts from a tornado during construction would be low***. The risks posed to construction safety by climate and severe weather would be mitigated through compliance with all applicable industry standards and with federal, state, and local regulatory requirements (FG Alliance, 2006c).

Severe or extreme drought conditions could increase the potential for wildfires in the area. Drought conditions would also increase the number of water trucks needed to reduce fugitive dust emissions and to support other construction activities. In dry, hot weather, construction workers may need to wear a dust mask and work for shorter time intervals between breaks.

Sequestration Site

Severe temperature or weather conditions could temporarily delay construction at the proposed sequestration site. Portions of the proposed sequestration site would be within the 100-year floodplain, so there would be a possibility for flood conditions during construction. However, because construction activities at the proposed sequestration site would be performed over a relatively short time, the potential impact of flood on construction activities would be minimal.

It would also be possible for a strong tornado to impact construction activities at the proposed sequestration site. ***The tornado frequency is equivalent to approximately 7 F1 or greater tornadoes over a 50 year period for an area of 850 square miles (2,202 square kilometers). The probability of a tornado greater than F1 intensity within Freestone County is approximately 1 every 28 years and the sequestration site represents 0.28 percent of the land area in county. Therefore,*** it is unlikely that a strong tornado would have a direct or indirect impact on construction activities at the proposed sequestration site.

Utility Corridors

Severe temperature or weather conditions could temporarily delay construction at the proposed utility corridors. The electrical corridor would span several miles and portions of the corridor would be within the 100-year floodplain. The sequestration corridor would span as much as 59 miles (95 kilometers) across regions within the 100-year floodplain. Accordingly, the construction activities along these corridors could be affected by flood conditions in the region. However, because only portions of the corridors would cross the 100-year floodplain, and given the limited time of construction along any portion of the corridor, the possibility that a flood would have direct or indirect impacts on construction would be low.

It would also be possible for a strong tornado to impact corridor construction activities. However, because construction activities would occur over a relatively small area and for a limited time, and the probability that a strong tornado would have a direct or indirect impact on utility corridor construction activities ***is unlikely***.

Transportation Corridors

There would be no direct or indirect impact of climate or severe weather on transportation infrastructure corridors because new roads or rail lines would not be required.

6.3.3.2 Operational Impacts

Power Plant Site

It is unlikely that operations at the proposed power plant site would be directly or indirectly affected by temperature or snowfall extremes in the region. Historically, summer temperatures are very warm, winters are mild, and significant snowfalls are rare. The proposed power plant site would be designed to operate under the expected range of temperature and snowfall conditions.

Topographic features around the proposed power plant emissions stack could potentially influence the effect of stack emissions downwash. In addition, water vaporization from cooling tower operation would potentially contribute to local fog conditions. Cooling tower “fogging” occurs when the condensed water vapor plume comes in contact with the ground for short time periods near the tower. Although this potential impact is referred to as fogging, cooling tower plume touchdown or fogging is usually a temporary event for only a few operational hours. Section 6.2 provides further discussion.

The possibility of a strong tornado in the region poses the potential for both direct and indirect impacts on power plant operations. A strong tornado could directly impact plant operations if sufficient damage were incurred at the plant site. Indirect impacts could occur if a strong tornado struck nearby communities and affected the ability of workers or supplies to reach the site. ***The tornado frequency is equivalent to approximately 7 F1 or greater tornadoes over a 50 year period for an area of 850 square miles (2,202 square kilometers). The probability of a tornado greater than F1 intensity across the three counties is approximately 1 every 2 to 3 years and the power plant site represents 0.02 percent of the combined land area of the counties; therefore, the chance for significant direct and indirect impacts from a tornado during operations would be low.***

It is also very unlikely that a flood would cause a direct or indirect impact on operations at the proposed power plant site because the site would be located outside of the 500-year floodplain. The risks posed on operational safety would be mitigated through compliance with all applicable industry standards and with federal, state, and local regulatory requirements.

Severe or extreme drought conditions could increase the potential for wildfires in the area. Ready availability of water is crucial for both fire protection and daily power plant operations. Because severe to extreme drought conditions are likely over the planned life of the facility, contingency plans and design features must be established to address these conditions to ensure that the necessary water is always available.

Sequestration Site

Operations at the proposed sequestration sites could be affected by climate and severe weather conditions in the region. The Trinity River flows through two of the three proposed sequestration sites, so there would be a possibility for flood conditions. To mitigate potential impacts, injection equipment would be installed at topologically favorable locations (those outside of floodplain areas) within these proposed sequestration sites.

It would also be possible for a strong tornado to affect operations at the proposed sequestration site. ***The tornado frequency is equivalent to approximately 7 F1 or greater tornadoes over a 50 year period for an area of 850 square miles (2,202 square kilometers). The probability of a tornado greater than F1 intensity within Freestone County is approximately 1 every 28 years and the sequestration site represents 0.28 percent of the land area in county; therefore*** it is unlikely that a strong tornado would have a direct or indirect impact on operations.

Utility Corridors

Climate or severe weather would not impact operations of utilities that would be installed underground. However, severe weather would potentially affect operations of the utility corridor components installed above ground (e.g., electrical transmission lines, pump stations). Portions of the utility corridors would be located within the 100-year floodplain, so there would be some potential for impact due to a flood. This could be mitigated through engineering design and placement of equipment in topologically favorable locations.

Transportation Corridors

Operation of the transportation corridors could be affected by severe weather conditions in the region. Cold weather, snow, and icy conditions could interfere with the material deliveries to and from the site by road or rail. However, because the region's climate is generally mild and snowfall is rare, the potential impact of these conditions would be low.

Because portions of the transportation corridors would be within the 100-year floodplain, road and rail travel could be interrupted by localized flood conditions; however, these effects would most likely be small and temporary.

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6.4 GEOLOGY

6.4.1 INTRODUCTION

The geologic resources of the proposed Jewett Power Plant Site, sequestration site, and related infrastructure corridors are described in this section, followed by a discussion of the potential impacts to these resources.

6.4.1.1 Region of Influence

There are three ROIs for geologic resources. The first ROI includes the land area on the surface that could be directly affected by construction and operation of the FutureGen Project at the proposed Jewett Power Plant Site and sequestration site. The second ROI includes the subsurface geology related to the radius of the injected CO_2 plume. ***Numerical modeling indicates that after injecting 2.8 million tons (2.5 MMT) of CO_2 per year for 20 years, the plume radius resulting after 50 years (20 years of injection followed by 30 years of spreading) would be 1.7 miles (2.7 kilometers), equal to an area of 5,484 acres (2,220 hectares.)*** (FG Alliance, 2006c). The plume radius and land area above the CO_2 plume are shown in Figure 6.4-1. The third ROI is a wider area (100 miles [160.9 kilometers]) that was evaluated to include potential effects from seismic activity.

6.4.1.2 Method of Analysis

The geologic setting includes the near-surface geology of the entire project and all deeper strata that make up the proposed sequestration reservoir. DOE evaluated the potential effects of the construction and operation of the proposed project on specific geologic attributes. In addition, DOE assessed the potential for impacts on the project due to geologic forces (e.g., earthquakes). The potential for impacts was based on the following criteria:

- Occurrence of local seismic destabilization (induced seismicity) and damage to structures;
- Occurrence of geologic-related events (e.g., earthquake, landslides, sinkholes);
- Destruction of high-value mineral resources or unique geologic formations, or rendering them inaccessible;
- Alteration of geologic formations;
- Migration of sequestered CO_2 through faults, inadequate caprock or other pathways such as abandoned or unplugged wells;
- Human exposure to radon gas; and
- Noticeable ground heave or upward vertical displacement of the ground surface.

DOE based its evaluation on a review of reports from state geologic surveys and information provided in the Jewett EIV (FG Alliance, 2006c).

DOE identified uncertainties in relation to geological resources at the Jewett Site. These include the porosity and permeability of the target formation where CO_2 would be sequestered. Analog well data was analyzed; however, site-specific test well data was not collected. Detailed geologic mapping has been conducted at the proposed Jewett Sequestration Site, and a fault has been identified in the subsurface ROI. Although it appears that this is a "sealing" fault, as opposed to a transmissive one, there is uncertainty concerning the transmissivity of this fault, and the potential presence of other faults in the area. In this case, regional geologic maps and tectonic stress regimes were analyzed using best professional judgment to determine the likelihood of other faults in the area.

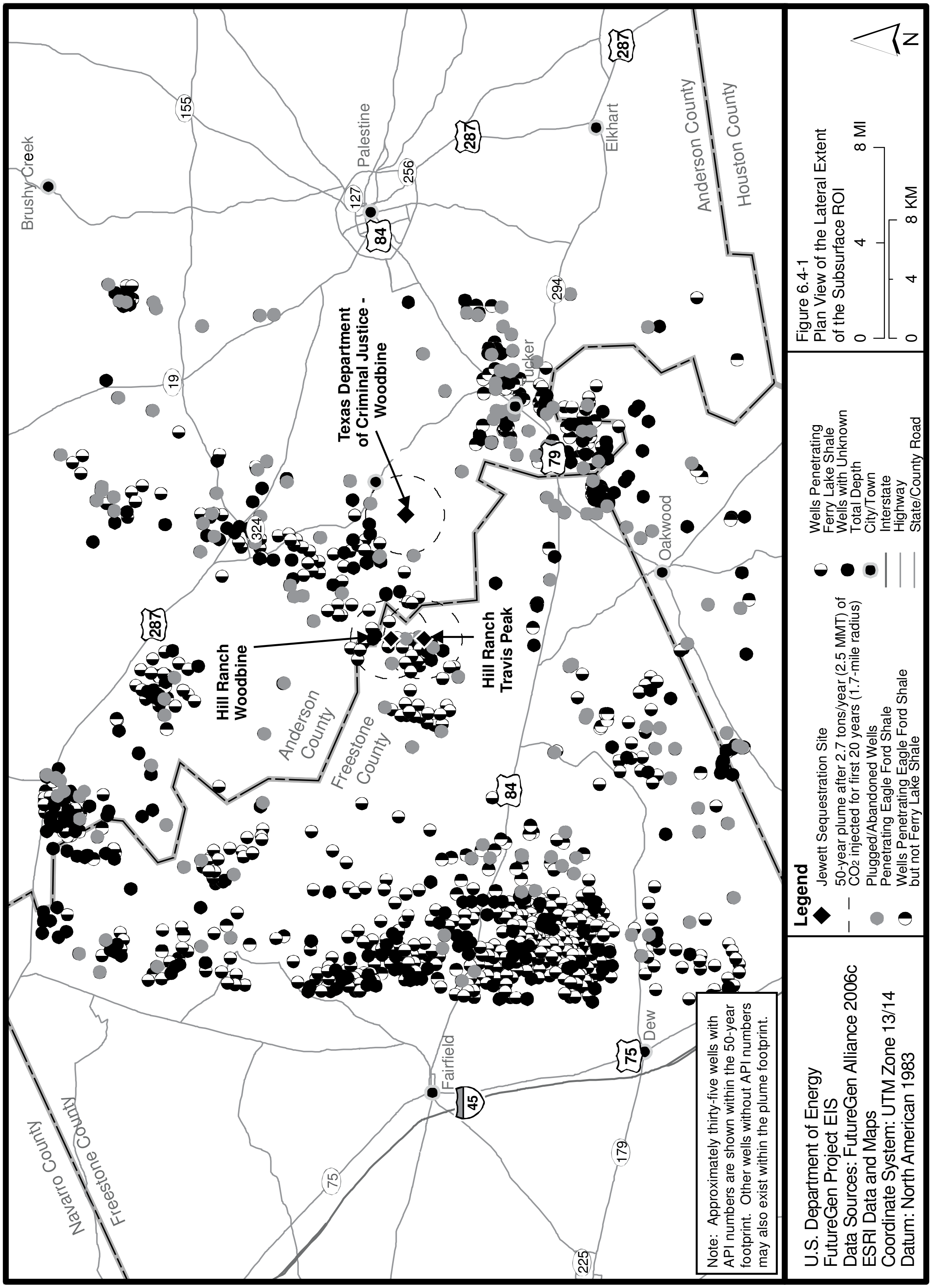


Figure 6.4-1
Plan View of the Lateral Extent of the Subsurface ROI

6.4.2 AFFECTED ENVIRONMENT

6.4.2.1 Geology

The proposed Jewett Power Plant Site is 400 acres (162 hectares) in size. The entire site consists of land reclaimed after the mining of lignite coal. The elevation of the proposed site varies from a high of 492 feet (150 meters) above mean sea level (AMSL) to a low of 426 feet (130 meters) AMSL.

The Jewett area is located within the East Texas Salt Basin, one of the basins that formed marginally to the Gulf of Mexico during the early Mesozoic. About 3.7 miles (6 kilometers) of Mesozoic and Tertiary sediment was deposited in this basin.

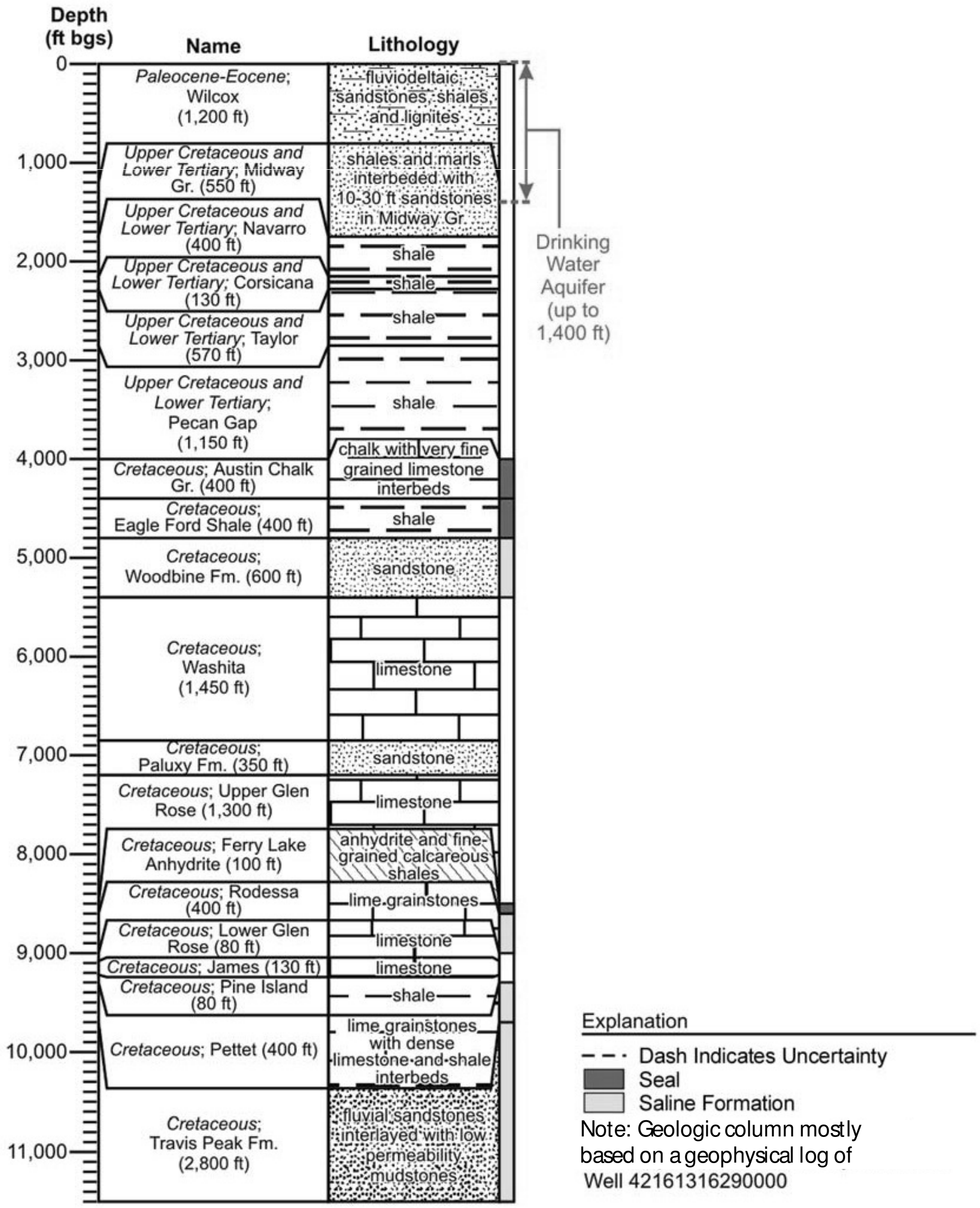
Figure 6.4-2 is a stratigraphic column of the geology beneath the proposed Jewett Sequestration Site. The bedrock at the proposed power plant site is the Paleocene-Eocene-age Calvert Bluff formation, which is part of the Wilcox Group. This formation consists mostly of mudstone with various amounts of sandstone, lignite, and ironstone concretions. The lignite seams are typically 1 to 20 feet (0.3 to 6.1 meters) thick and occur mostly in the lower part of the formation (FG Alliance, 2006c). The geology at the proposed plant site and other areas where construction would occur is similar. The Wilcox Group strata are estimated to be approximately 0.2 mile (0.3 kilometer) thick at the proposed injection site and are underlain by approximately 0.8 mile (1.3 kilometers) of primarily shale, with some minor sandstone and chalk/limestone.

Lying below these strata is the proposed primary target formation (or sequestration reservoir) for CO_2 injection, the Cretaceous-age Woodbine formation. This formation is brine saturated and is 500 feet (152.4 meters) thick below the project site. The Woodbine is a quartzarenite sandstone, or a “clean” sandstone consisting of greater than 95 percent quartz. It is overlain by 400 feet (121.9 meters) of low permeability shales of the Eagle Ford Shale formation, which is the primary seal for the sequestration reservoir.

The Cretaceous-age Travis Peak formation is proposed as an optional target reservoir of low permeability for additional research purposes. It occurs at a depth of 2 miles (3.2 kilometers) below the earth’s surface (see Figure 6.4-2). At the Jewett Site, the Travis Peak is estimated to consist of up to 0.4 miles (0.6 kilometers) of sandstones interbedded with mudstones (FG Alliance, 2006c).

Structural dip on the Woodbine and Travis Peak formations is less than one degree. The principal tectonic features of the region include down-to-the coast normal faults southeast and northwest of the injection sites, and various salt tectonic features. The Mexia-Talco fault zone is located 30 to 35 miles (48.1 to 56.3 kilometers) west of the injection site, and is the location of the nearest major faults to the proposed Jewett Sequestration Site. This area is outside of the subsurface ROI, and also contains significant hydrocarbon accumulations indicating that faults in that area act as seals.

Within 10 miles (16.1 kilometers) of the proposed injection wells, surface faults are present and are clustered around salt domes located south and east of the injection wells. Throws (i.e., distance of fault slippage, or movement) for most of these surface faults are not large, with generally less than 200 feet (61 meters) of displacement. These faults generally trend southwest to northeast. A larger fault with a throw of about 600 feet (183 meters) is associated with the Butler salt dome, about 10 miles (16.1 kilometers) south and east of the proposed sequestration site. Also within 10 miles (16.1 kilometers) of the sequestration site are other salt tectonic features related to growth of the salt domes. East-west trending graben structures are also present that are expected to have 50 to 200 feet (15.2 to 61 meters) of throw.



ft bgs= feet below ground surface

Source: FG Alliance, 2006c

Figure 6.4-2. Stratigraphy of the Jewett Injection Area

A south-dipping normal fault, trending almost directly west to east, is present within the subsurface ROI. Three-dimensional seismic data reveal the fault's presence at the southern margin of the proposed injection zone. The injection well as proposed would be located to the north of this fault and would not be cut by the fault. The fault has been interpreted as having a throw of approximately 200 feet (61 meters) at the stratigraphic level of the Rodessa carbonates, and it has been concluded that because the Eagle Ford Shale is 400 feet (122 meters) thick in the immediate area of the fault, the fault places shale against shale and should act as a competent seal. In addition, there are small normal faults that cut the Woodbine within the sequestration site, but it is reported that they do not offset the Eagle Ford formation caprock seal (FG Alliance, 2006c). These faults are still potential planes of weakness within the subsurface ROI.

Because of the presence of faults in the area, a regional geologic stress analysis was conducted for this EIS to yield insight into the orientation of open fractures and possible transmissive faults. The stress trend, or principle direction, is southwest to northeast. Stress values are dependant on depth and vertical stresses are greater than the horizontal stresses. The proposed injection site is in an overall normal-fault type extensional stress regime. Faults and fractures parallel, or sub-parallel, to the greatest principal stress in this setting are known to be more likely to be transmissive, assuming the stress differentials between the vertical overburden and the minimum horizontal principal stress are large enough to generate the critical shear stress necessary for opening/movement (FG Alliance, 2006c); and faults or fractures not parallel to this direction are more likely to be sealing. As mentioned above, most faults within 10 miles (16.1 kilometers) of the proposed Jewett sequestration site trend southwest to northeast and are thus more likely to be transmissive. However, the west to east trending normal fault present at the sequestration site is not parallel or sub-parallel to the greatest principal stress direction, and therefore is likely to be sealing. However, if this fault is not sealed, it could act as a pathway to potentially more transmissive southwest to northeast-trending faults.

Geological Resources in the Jewett Area

The geologic resources present in the overall project area (inclusive of the proposed power plant site, sequestration site, and utility and transportation corridors) are coal (lignite) and oil and gas. The proposed power plant site and portions of the corridors are located on reclaimed land of a former lignite mine. Several active gas wells are located within the proposed pipeline corridor.

The project area should not be affected by subsidence (sinking or lowering of the ground surface), because most factors known to cause subsidence are not present in the project area. Such factors include undermining by coal or other mines, and withdrawal of large quantities of water from aquifers, although groundwater is planned as the source of supply for the power plant.

Over 1,200 oil and gas wells exist within the vicinity (i.e., within 10 miles [16 kilometers]) of the proposed Jewett Sequestration Site (refer to Figure 6.4-1). Of these, 275 are of unknown depth. The total depth of the remaining 934 wells ranges from 527 feet to 3.4 miles (160.6 meters to 5.5 kilometers) (UTA, 2006). Wells that penetrate the primary seal are of primary importance because they pose the highest risk for CO_2 leakage. The primary seal for the Travis Peak formation is the Ferry Lake formation, a regional seal of low permeability anhydrite and fine-grained calcareous shale that occurs at a depth of approximately 1.6 miles (2.6 kilometers) below the ground surface. The primary sequestration reservoir at this site is the Woodbine formation, which is overlain by the Eagle Ford Shale occurring at a depth of approximately 0.8 mile (1.3 kilometers) below ground surface. ***It was reported that 57 known wells that penetrate the Eagle Ford Shale were counted within a 2.2 mile (3.6 kilometer) radius of the two proposed Woodbine well sites (FG Alliance, 2006c). Based on comments received from the Jewett Site proponents on the Draft EIS, 38 known wells penetrate the Eagle Ford Shale within the 1.7 mile (2.7 kilometer) 50-year plume radius of the Woodbine well sites and 46 are within the 50-year plume radius of both the Woodbine and Travis Peak well sites.***

6.4.2.2 Seismic Activity

The proposed Jewett Site is located roughly 400 miles (644 kilometers) southwest of an area of seismic activity known as the New Madrid Fault Zone, which is located in the general area of the common borders of southern Illinois, western Kentucky and Tennessee, and southeastern Missouri. This area has spawned the most powerful earthquakes recorded in the continental United States (Richter magnitudes of 8.0). However, the proposed Jewett location is far enough away that earthquakes are not commonly felt.

The closest earthquake to the proposed power plant site occurred in 1932 and was centered about 50 miles (81 kilometers) northwest of the project area. It had a Richter magnitude of 4.0, and was likely induced by oil production (FG Alliance, 2006c). Earthquakes registered at this magnitude cause indoor items to shake, but significant damage to well built structures is rare.

A search of the United States Geological Survey (USGS) database of historic earthquakes shows that since 1974, four earthquakes have occurred within 100 miles (161 kilometers) of the approximate midway point between the proposed power plant and sequestration sites. The Richter magnitude of the earthquakes ranged from 2.3 to 3.4. The most recent seismic event, on May 31, 1997, was a 3.4 magnitude earthquake centered 110 miles (177 kilometers) from the midpoint between the power plant and sequestration site (USGS, 2006).

East Texas is not seismically active. As discussed previously, minor earthquakes are known to occasionally occur (with associated damage on the order of items falling from shelves). Devastating earthquakes (i.e., almost complete destruction over large areas) are very rare in the central U.S., occurring about once every 700 to 1,200 years. The last strong earthquake to strike the Midwest happened on October 31, 1895. The quake, centered just south of Illinois in Charleston, Missouri, had an estimated magnitude of 6.8 on the Richter scale. Although this quake was widely felt throughout the mid-continental United States, it caused serious damage only in the immediate Charleston area (ISGS, 1995).

6.4.2.3 Target Formation Properties

Characteristics

Depth

The proposed sequestration site is underlain by a deep saline formation with four main injection zones: the Woodbine sandstone, the Rodessa and Pettet lime grainstones, and the Travis Peak formation, which are all located beneath a primary seal, the Eagle Ford Shale.

The primary target formation is the Woodbine formation that extends from 1.0 mile (1.6 kilometers) to 1.1 miles (1.8 kilometers) below the ground surface, while the Travis Peak and associated overlying rocks (the Rodessa and Pettet lime grainstones) extend from 1.7 miles (2.7 kilometers) to approximately 2.1 miles (3.4 kilometers) below the ground surface.

Injection Rate Capacity

Due to their previous depositional environment (wave-dominated delta), the Woodbine sandstones are known to be locally very permeable. The depositional environment affects lateral changes in Woodbine porosity and permeability that would affect well plume geometry. Although numerical modeling indicates that the proposed injection rate could be met by a single Woodbine well, two primary injection wells separated by approximately 6 miles (9.6 kilometers) have been proposed to avoid plume interference caused by potential lateral changes in Woodbine porosity and permeability. The second well helps to reduce plume size and provides backup capacity during well maintenance and monitoring activities (FG Alliance, 2006c). A third well is proposed to be an experimental well in the Travis Peak formation, which has a much lower permeability than the Woodbine formation.

Because of the Travis Peak formation's low reservoir permeabilities and rapid lateral pinch-outs of individual sand bodies, the injection rate here is limited by the maximum pressure that can be safely maintained without causing reservoir fracturing. Site-specific data collection would be necessary to determine the maximum safe injection pressure.

Storage Capacity

The Woodbine formation is a 500-foot (152.4-meter) thick clean sandstone composed of greater than 95 percent quartz. Lower Woodbine sandstones typically have porosity values of 25 percent, with permeability values of several hundreds of milidarcies (md) to 1,200 md. Upper Woodbine sandstones are more porous (25 to 30 percent), with permeability values of greater than 3,000 md.

The Travis Peak formation, the optional secondary target sequestration formation, consists of 0.5 mile (0.8 kilometer) of stacked fluvial sandstones interbedded with low-permeability mudstones, comprising 800 to 900 feet (243.8 to 274.3 meters) of net sandstone, with porosity ranging from 5 percent to 8 percent. The Pettet carbonate grainstone overlies the Travis Peak, is approximately 400 feet (122 meters) thick, and consists of lenticular, porous limestones with dense limestones and thin shale interbeds. The Pettet's permeability is reported to be up to 125 md. The Rodessa carbonate, below the Ferry Lake Anhydrite, is 350 to 400 feet (106.7 to 121.9 meters) thick with 10- to 40-foot (3- to 12-meter) thick zones of permeability up to 125 md (FG Alliance, 2006c).

Numerical modeling indicates that the target formations would have adequate capacity. However, modeling indicates that the Travis Peak formation would hold 5.5 million tons (5.0 MMT) of CO_2 during 20 years of injection and after that time CO_2 would reach the proposed production/pressure relief wells (FG Alliance, 2006c). To increase reservoir capacity, four brine production wells would be located around the injection well to this formation.

Seals, Penetrations, and Faults

Primary Seal

The ultimate or primary caprock seal for the Jewett Sequestration Site is the Eagle Ford Shale. The Eagle Ford is the main seal for some of the largest oilfields in East Texas and is approximately 400 feet (122 meters) thick and has a permeability greater than or equal to 0.01 md in the CO_2 sequestration area. Over 0.4 mile (0.6 kilometers) of low permeability carbonates and shales above the Eagle Ford provide additional barriers to vertical migration of CO_2.

Secondary Seal

Another minor seal for the Travis Peak formation optional reservoir, the Ferry Lake formation, is located approximately 0.6 mile (1.0 kilometers) below the Woodbine. The Ferry Lake consists of interbedded anhydrite, and low permeability carbonates and cemented quartz sandstone. Anhydrites are known to have low permeability and also tend to heal if fractured. The Rodessa formation, directly underlying the Ferry Lake, often has a well-developed anhydrite section that would also retard vertical flow (FG Alliance, 2006c).

Existing well bores are potential pathways for vertical migration of CO_2, especially if they are known to penetrate the primary seal and are not properly abandoned. Fifty-seven wells that penetrate the primary seal are located within the maximum plume footprint of the two Woodbine CO_2 injection wells. Twenty-nine of these wells have abandonment records on file at the Railroad Commission of Texas (FG Alliance, 2006c).

One of the proposed CO_2 injection wells would be located to the north of a south-dipping normal fault that intersects the primary seal, but it is interpreted to be a sealing fault as it does not offset the Eagle Ford Shale, but instead places shale against shale.

Relation of Primary Seal to Active or Transmissive Faults

As discussed previously, the known fault in the subsurface ROI (located within the proposed sequestration reservoir, the Woodbine formation) is thought to be a sealing fault. The area is not seismically active and no active or transmissive faults are expected to be present in the area.

6.4.2.4 Geologic Sequestration Studies, Characteristics and Risk Assessment

Currently, there are four CO_2 injection sites worldwide under detailed study. These are the Rangely, Weyburn, In Salah, and Sleipner projects. They are located in the United States, Canada, Algeria, and Norway, respectively. Rangely and Weyburn involve enhanced oil recovery (EOR), In Salah involves enhanced gas recovery (EGR) and saline reservoir injection, and Sleipner is a storage project located off shore in the North Sea.

A database of these and other geologic storage facilities was created and used in conducting the human health risk assessment for this EIS (Section 6.17). These studies of natural and industrial analogs for geologic storage of CO_2 (i.e., sites in similar geologic and hydraulic settings with similar anthropogenic influences) provide evidence for the feasibility of geologic containment over the long-term and for characterizing the nature of potential risks from surface leakage, should it occur. A more detailed description of these studies, their characteristics, and the state of risk assessment for geologic sequestration of CO_2 is provided in Section 6.17 and Appendix D.

6.4.3 IMPACTS

6.4.3.1 Construction Impacts

Power Plant Site

The surficial geology of the power plant site includes sandstones and mudstones. There are no geologic features present that would affect construction of the power plant infrastructure. There would be no noticeable impact to the availability of lignite coal in the area from construction of the power plant and other facilities. However, aggregate and other geologic resources (e.g., sand) would be required to support construction activities; these resources are readily available near the proposed plant site and the quantities required for construction of the power plant would not have a noticeable effect on their availability. Additional discussion of the availability of construction materials is addressed in Section 6.16.

The relatively flat surface topography of the power plant site precludes any potential impacts from landslides or other slope failures during construction. Similarly, because the area is not seismically active and most of the earthquakes in eastern Texas have a Richter magnitude below 3.0, it is not expected that seismic activity would affect construction of the power plant.

Sequestration Site

Potential impacts to geologic resources and impacts from geologic processes or features such as earthquakes or landslides would be the same for construction at the sequestration site as discussed above for the power plant site. Each injection well (and any deep monitoring wells placed in the target formation – see discussion in Section ***2.5.2.2***) would penetrate approximately 1 mile (1.6 kilometers) of bedrock to the primary target formation (or 2.1 miles [3.4 kilometers] for the secondary target formation). It is believed that mineral resources would not be impacted by the installation of the injection wells or deep monitoring wells.

Utility Corridors

Potential impacts to geologic resources, and impacts from geologic processes or features such as earthquakes or landslides, would be the same for construction along the proposed utility corridors as discussed above for the power plant site.

Transportation Corridors

Potential impacts to geologic resources, and impacts from geologic processes or features such as earthquakes or landslides, would be the same for construction along the proposed transportation infrastructure corridors as discussed above for the power plant site.

6.4.3.2 Operational Impacts

Power Plant Site

During power plant operations, no additional impacts to geologic resources would be expected. The power plant site's relatively flat surface topography and lack of karst geology precludes any potential impacts from landslides, other slope failures, or sinkhole development during operation. Similarly, because the area is not seismically active and only minor earthquakes have affected the project area, it is not expected that seismic activity would affect operation of the power plant.

Sequestration Site

The potential impacts to geologic resources, and impacts to the sequestration site from geologic processes, during operation are discussed below.

When CO_2 is injected into a deep brine-saturated (saline) permeable formation in a liquid-like (i.e., supercritical) dense phase, it is immiscible in, and less dense than, water. This would be the case at the Jewett Sequestration Site. The CO_2 would displace some of the brine. In addition to displacement of brine, CO_2 may dissolve in or mix with the brine thereby causing a slight acidification of the water, a reaction with the mineral grains, or be trapped in the pore spaces by capillary forces. Some combination of these processes is likely, depending on the specific conditions encountered in the reservoir.

Geochemical modeling of the potential pH changes was conducted for this EIS. The modeling showed that the pH of the brine in the Woodbine and Travis Peak formations would be expected to drop from about 6.5 to 3.3 over many years, creating acidic brine. However, the Woodbine is made up of quartz-rich sandstone that is extremely resistant to chemical changes. Therefore, acidification of the brine solution would not be expected to substantially alter the Woodbine formation. The Travis Peak formation would be more susceptible to geochemical reactions over very long periods of time (hundreds to thousands of years).

CO_2 emitted from the power plant would include some H_2S. Because of the significant expense required to separate these two elements, it is possible that the Alliance may conduct tests where greater concentrations of H_2S are included in the gas stream to be sequestered. Therefore, geochemical modeling of the potential changes that could occur to the Eagle Ford Shale (caprock) from the introduction of H_2S

into the reservoir formation was conducted. It was concluded that the most significant effect is that the H_2S concentration in the sequestered gas mixture would be reduced with only very small (less than 1 percent) changes to the permeability of the Eagle Ford seal, due to precipitation of minerals contacting H_2S that would reduce the porosity of the formation.

Increases in pore pressure associated with the injection of CO_2 can decrease friction on existing faults, and may cause the faults to become transmissive or to slip, particularly in areas where the regional stress regime is extensional as opposed to compressive. Induced seismic activity due to oil production activities may have caused a 4.0 magnitude earthquake approximately 30 miles (48 kilometers) west-southwest of the proposed Jewett Injection Site between Mexia and Wortham in 1932 (FG Alliance, 2006c). Because the regional stress regime is extentional, decrease of friction on fault surfaces due to CO_2 injection is a concern at the Jewett Sequestration Site. The risk assessment conducted for this EIS (Appendix D) estimates, however, a very low probability of induced seismicity (1 in 10,000 over 5,000 years).

Although injection-induced seismicity is unlikely, monitoring methods discussed in Section 2.5.2.2 would alert the operator of pressure build-up that could lead to induced seismicity, where appropriate remediation strategies could be employed to prevent or minimize adverse impacts.

The injection pressures that would cause new or existing fractures to open in the target reservoir and caprock are not known and would need to be determined as part of the permitting process. Requiring injection pressures to be substantially below the fracture opening and fracture closure pressures would greatly lower the risk of accidental overpressure and induced fracturing of the formation, the seal, or cements in wellbores, as well as lowering the risk of opening existing fractures. Site-specific injection pressure limits may be established as part of the permitting process.

Numerical modeling was conducted to estimate the potential CO_2 plume migration if an undetected transmissive fracture zone or fault was present that through-cuts the Eagle Ford Shale above the injection point in the Woodbine formation. This fracture zone or transmissive fault was assumed to be 0.6 mile (1 kilometer) long, with permeabilities well in excess of the permeability of the Eagle Ford Shale (four cases were modeled with permeabilities ranging from 0.01 to 1,000 md). Only narrow faults were evaluated because fracture/ fault zones larger than 33 feet (10.1 meters) wide could be detected through geophysical methods and investigated before initiation of an injection program. Injection wells would be relocated, if necessary, to avoid such faults.

The results of the numerical modeling of the fault leakage scenario for the Jewett Site indicate that, for permeabilities of 1 md and higher, the amount of CO_2 leakage through the fault would be relatively small, as measured by the CO_2 flux rates, extent of the plume, and CO_2 gas pressure at the base of the overlying Pecan Gap formation. The steady-state flux rate for the higher permeability cases was about 157 tons of CO_2 per year or 0.006 percent of the 2.8 million tons (2.5 MMT) per year injection rate. The maximum plume extent occurred for the higher permeability faults and was 830 feet (253 meters) after 1,000 years. The plume extent for the 0.01 md case was zero for the first 600 years and did not exceed approximately 50 feet (15 meters) after 1,000 years; significant permeation of the Eagle Ford shales is clearly unlikely to occur at permeabilities less than 0.01 md (FG Alliance, 2006c).

The potential for leakage of CO_2 from the sequestration reservoir by means other than faults would be a potential impact of concern. The injection wells themselves (and any deep monitoring wells placed in the target formation) would be one of the likely paths for CO_2 migration from the reservoir, as by their nature they perforate all the seals present. Unknown wells and improperly plugged existing well bores within the ROI could potentially leak CO_2. The Jewett Site subsurface ROI is surrounded by operating and abandoned petroleum exploration and production wells, with over 1,000 within 10 miles

(16.1 kilometers) of the sequestration injection site. Fifty-seven wells are reported to penetrate the primary seal, the Eagle Ford Shale (FG Alliance, 2006c). In addition to these known wells, there may be other undocumented wells located within the subsurface ROI that may or may not be properly abandoned. However, as part of the site-specific assessment to be conducted on the selected site, geophysical surveys will be conducted to locate existing wells, and if found to be improperly abandoned, such wells could be properly sealed and abandoned to meet state regulations and prevent leakage. The risk assessment estimates the probability of leakage from such wells (Appendix D).

An earthquake has the potential to affect the injection wells. If a fault was penetrated by the well bore, the injection well's casing could be sheared if movement occurred on that fault during a seismic event. However, vibrations from an earthquake would not likely cause faulting or affect the integrity of the well. Minor earthquakes do occur in eastern Texas, but the project area is not seismically active. Eastern Texas lies in a stable continental area where there is little risk of new faulting. Thus, it is unlikely that the well's casings would be sheared by natural earthquakes.

There are several sequestration features that indicate that CO_2 would be retained in the proposed injection formation, the Woodbine sandstone, including:

- The Woodbine formation is 500 feet (152.4 meters) thick and is composed of very permeable sandstone and modeling shows that more than adequate storage capacity exists in the proposed sequestration reservoirs.
- Approximately 3,000 feet (914 meters) of low permeability carbonates and shales above the Eagle Ford should act as multiple barriers to the upward migration of CO_2.
- The dominantly quartz mineralogy of the Woodbine formation would cause geochemical reactions to be primarily simple dissolution of the CO_2 in the brine formation water.
- The primary seal, the Eagle Ford Shale, is a low-permeability shale with a thickness of approximately 400 feet (122 meters) in the subsurface ROI area that is also the main seal for some of the largest oil fields in Texas.

There are many variables that affect the potential to increase pore pressure enough to cause vertical displacement. Collection of site-specific data including porosity, permeability and mean effective stress would allow for future modeling of the predicted pressure increases and subsequent potential for ground heave at the Jewett Sequestration Site and surrounding area. If a potential problem is identified, injection pressures could be maintained below the levels that would cause heaving.

The U.S. EPA has mapped most of Texas, including the Jewett area, as an area with a low potential for radon to exceed the recommended upper limit for air concentrations within buildings. Thus, it is unlikely that if CO_2 were to escape the sequestration reservoir and increase pore pressures in the vadose zone (near surface unsaturated soils above the water table), there would be radon present that could potentially be displaced and forced into buildings. As discussed above, several sequestration features indicate that CO_2 should be retained in the sequestration reservoir. If CO_2 were to leak, however, radon transport induced by CO_2 leakage would be highly localized over the point of CO_2 leakage. The risk assessment conducted for this EIS addressed the potential for adverse impacts from radon displacement (Appendix D). Data concerning potential existing radon levels from state and local sources were used as the baseline. Using conservative assumptions on increases of radon via displacement by CO_2, it was concluded that the situation with respect to radon would remain unchanged as to whether EPA-established action levels would be exceeded. This indicates that there would be no incremental risks above background from radon at the Jewett Site.

An offer has been made for a 50-year lease on the sequestration site with 100 percent surface access and a waiver of mineral and water rights for at least three injection sites totaling approximately

1,550 acres (627 hectares) in two locations (FG Alliance, 2006c). All mineral rights needed to conduct sequestration would be acquired. Conflicts with commercial accessibility to high-value mineral resources or unique geologic formations would be dealt with as part of the acquisition of mineral rights.

Utility Corridors

Potential impacts to geologic resources, and impacts from geologic processes or features such as earthquakes or karst geology, would be the same for operation of the proposed utility corridors as discussed above for the power plant site.

Transportation Corridors

Potential impacts to geologic resources, and impacts from geologic processes or features such as earthquakes or karst geology, would be the same for operation of the proposed transportation infrastructure corridors as discussed above for the power plant site.

6.4.3.3 Fate and Transport of Injected/Sequestered CO_2

As mentioned above, in saline formations, supercritical CO_2 is less dense than water, which creates strong buoyancy forces that drive CO_2 upwards. After reaching the top of the reservoir formation, CO_2 could continue to migrate as a separate phase until it is trapped as residual CO_2 saturation or in local structural or stratigraphic traps within the sealing formation. In the longer term, significant quantities of CO_2 (up to 30 percent) would dissolve in the formation water and then migrate with the groundwater. Reservoir studies and simulations for the Sleipner Project have shown that CO_2-saturated brine would eventually become denser and sink, thereby eliminating the potential for long-term leakage. These reactions, however, may take hundreds to thousands of years (IPCC, 2005).

Numerical modeling indicates that the plume radius for each injection well from injecting 2.8 million tons (2.5 MMT) of CO_2 per year for 20 years would be 1.7 miles (2.7 kilometers), equal to an area of 5,484 acres (2,220 hectares) (FG Alliance, 2006c). These sequestration footprints are shown in Figure 6.4-1.

Most geological characteristics of the area (simple sedimentary structure with a low rate of dip; a deep reservoir in a formation consisting of up to 500 feet [152.4 meters] of very permeable quartz-rich sandstone overlain by up to 400 feet [121.9 meters] of low permeability shale; and over 3,000 feet [914 meters] of overlying mostly fine grained carbonate rock that also includes many sequences of more and less permeable zones) indicate that it would be unlikely that CO_2 would migrate vertically for any significant distance.

However, due to the presence and orientation of fractures within 10 miles (16 kilometers) of the proposed Jewett Sequestration Site, transmissive fractures could be present in the subsurface ROI. If present, CO_2 could migrate along such paths. Horizontal open fractures within the Woodbine could cause the CO_2 to migrate farther laterally than the numerical modeling predicts. Vertical open fractures are more likely at depth than horizontal ones. Thus, if such fractures are present in the Eagle Ford formation within the ROI, they could promote vertical migration of CO_2. In order for the CO_2 to reach shallow potable groundwater or the biosphere, such fractures would need to penetrate and be open through, or connect in networks through, over 4,400 feet (1,341 meters) of various types of rock. Given the detailed knowledge of the geologic setting of the subsurface ROI at the Jewett Site, it is unlikely that such fractures are present; however, further site-specific geologic investigations would be necessary to verify this before initiating injection of CO_2. See Section 6.17 for a discussion of CO_2 transport assumptions and potential associated risks.

6.5 PHYSIOGRAPHY AND SOILS

6.5.1 INTRODUCTION

This section describes the physiography and soils associated with the proposed Jewett Power Plant Site, sequestration site, and related corridors.

6.5.1.1 Region of Influence

The ROI for physiography and soils is defined as a 1-mile (1.6-kilometer) radius around the boundaries proposed power plant site, sequestration site, reservoir, and utility corridors.

6.5.1.2 Method of Analysis

DOE reviewed reports from the U.S. Department of Agriculture (USDA), information provided in the Jewett EIV (FG Alliance, 2006c), and other available public data to assess the potential impacts of the proposed FutureGen Project on physiographic and soil resources. DOE assessed the potential for impacts based on the following criteria:

- Potential for permanent and temporary soil removal;
- Potential for soil erosion and compaction;
- Soil contamination due to spills of hazardous materials; and
- Potential to change soil characteristics and composition.

Some uncertainties were identified in relation to soil resources at the proposed Jewett Site such as the porosity and permeability of the various soils where the project infrastructure would be located. Uncertainties, based on the absence of site-specific data, are discussed as appropriate in the following analysis. Prime farmland is discussed in Section 6.11.

6.5.2 AFFECTED ENVIRONMENT

6.5.2.1 Physiography

The proposed Jewett Power Plant Site is located within the Gulf Coastal Plains physiographic province (UTA, 2006). The Gulf Coastal Plains include three subprovinces: the Coastal Prairies, the Interior Coastal Plains, and the Blackland Prairies. The Coastal Prairies begin at the Gulf of Mexico shoreline. Young deltaic sands, silts, and clays erode to nearly flat grasslands that form almost nonexistent slopes to the southeast. Trees are uncommon except locally along streams and in Oak mottes, growing on coarser underlying sediments of ancient streams. Minor steeper slopes, from 1.0 foot (0.3 meters) to as much as 9.0 feet (2.7 meters) high, have resulted from subsidence of deltaic sediments along faults over geologic time (thousands of years). Between Corpus Christi and Brownsville, broad sand sheets pocked by low dunes and blowouts forming ponds dominate the landscape (UTA, 2006).

The Interior Coastal Plains, where the proposed Jewett Power Plant Site is located, consist of alternating belts of resistant uncemented sands among weaker shales that erode into long, sandy ridges.

On the Blackland Prairies of the innermost Gulf Coastal Plains, chalks and marls weather to deep, black, fertile clay soils, in contrast with the thin red and tan sandy and clay soils of the Interior Gulf Coastal Plains. The blacklands have a gentle undulating surface, cleared of most natural vegetation and cultivated for crops (UTA, 2006).

From sea level at the Gulf of Mexico, the elevation of the Gulf Coastal Plains increases northward and westward. In the Austin San Antonio area, the average elevation is about 800 feet (244 meters). South of Del Rio, the western end of the Gulf Coastal Plains has an elevation of about 1,000 feet (305 meters).

6.5.2.2 Soils

The following section describes the different predominant soils at the power plant site, sequestration site, and utility and transportation corridors. Descriptions of the soil type characteristics and uses are presented in Table 6.5-1.

Table 6.5-1. Predominant Soil Types, Characteristics, and Uses in the Proposed Power Plant and Sequestration Sites and Related Corridors

Soil Type	Characteristics	Uses
Arenosa fine sand (ArC)	Deep, gently sloping to undulating (1 to 8 percent slopes), and somewhat excessively drained. It is on broad uplands. Rapid permeability and low available water capacity, results in very slow runoff and a very slight risk of water erosion. Soil blowing is a severe hazard in bare areas and at construction sites. Included with this soil in mapping are small areas of Padina and Silstid soils, both on a landscape similar to this mapping unit.	Used as rangeland, and is generally not used for crops due to droughtiness, low available water capacity, the soil's sandy surface layer, and the steepness of slope. This soil is well suited to roads, streets, and buildings.
Axtell fine sandy loam (AxB)	Deep, gently sloping (1 to 5 percent), and moderately well drained on uplands and old terraces. Slow permeability and moderately available water capacity result in medium to rapid runoff and a severe risk of a water erosion hazard. Included with this soil in mapping are areas of Crockett, Lufkin, Rader, and Tabor soils. Crockett and Tabor soils are in positions similar to those of the Axtell soil. Lufkin and Rader soils are in slightly lower positions.	Primarily used as pasture or hayland with the possibility of use as rangeland.
Cuthbert fine sandy loam (CtE)	Strongly sloping to moderately steep (5 to 15 percent) soil on upland side slopes. The surfaces are plane to slightly convex. Areas are irregular in shape and are generally parallel to drainageways. This soil is well drained and permeability is moderately slow. Combined with moderate available water capacity this soil type is characterized by its rapid surface runoff and severe water erosion hazard. Included with this soil in mapping are small areas of Kirvin and Wolfpen soils.	Used mainly as pasture and wildlife habitat. It is not suitable for cropland due to the combination of slope and surface runoff that creates a severe hazard of erosion. This soil is moderately suited for use as woodland and recreation. It is poorly suited for most urban uses and for growing native grasses.

Table 6.5-1. Predominant Soil Types, Characteristics, and Uses in the Proposed Power Plant and Sequestration Sites and Related Corridors

Soil Type	Characteristics	Uses
Cuthbert gravelly fine sandy loam (CvF)	Moderately steep to steep (15 to 30 percent) soil on upland side slopes. The surfaces are mainly slightly convex. This soil is well drained with moderately slow permeability. With moderate available water capacity, this soil type is characterized by its medium to high surface runoff and moderate water erosion hazard. Included with this soil in mapping are small areas of Kirvin and Wolfpen soils. Also included are Cuthbert soils with more than 35 percent gravel in the surface layer or with up to 10 percent of the surface covered by stones.	Used mainly as wildlife habitat, and is not suitable for pasture or cropland because of slope and the hazard of erosion. This soil is moderately used as woodland and is poorly suited to growing native grasses and for urban uses.
Cuthbert gravelly fine sandy loam (CzG)	Moderately steep to steep soil on low hills on the highest parts of the landscape. The surfaces are mostly slightly convex. Ironstone rocks, ranging from 3 inches (8 centimeters) to 4 feet (1.2 meters) across, cover 2 to 10 percent of the soil surface. This soil is well drained with moderately slow permeability. With moderate available water capacity, this soil type is characterized by its high surface runoff and severe water erosion hazard. Included with this soil in mapping are small areas of Kirvin and Wolfpen soils. The Kirvin soils are on the gently sloping tops of hills. The Wolfpen soils are in lower, more convex areas. Also included are areas of Cuthbert soils that do not have stones on the surface and a few small areas that have been mined for gravel.	Mainly used as wildlife habitat, and is not suitable for cropland due to slope, hazard of erosion, and large stones. This soil is moderately suited to use as woodland, and poorly suited to growing native grasses and for urban uses.
Cuthbert soils, graded (CxE)	Strongly sloping to moderately steep soil on uplands. The surfaces are slightly convex. The soil is well drained with moderately slow permeability and moderate available water capacity, resulting in medium to high surface runoff and a moderate risk of a water erosion hazard. Included with this soil in mapping are small areas of Kirvin soils and undisturbed Cuthbert soils. Also included are areas of graded Cuthbert soils that have a thin layer of original surface material and areas of Cuthbert soils that have slopes of more than 15 percent.	Soil is used mainly as wildlife habitat, and poorly suited to pastures of Coastal Bermuda grass, growing commercial timber, growing native grasses, and for most urban and recreational uses. This Cuthbert soil is not suitable for cropland due to slope and the hazard of erosion.

Table 6.5-1. Predominant Soil Types, Characteristics, and Uses in the Proposed Power Plant and Sequestration Sites and Related Corridors

Soil Type	Characteristics	Uses
Derly-Rader complex, 0 to 1 percent slopes (DrA)	These nearly level soils are on stream terraces. Derly The Derly soils are found in flat areas between mounds. These soils are poorly drained with low surface runoff and very slow permeability. The available water capacity is high and the water table can be found within a depth of 12 inches (31 centimeters) during the winter and spring. The soils have a slight water erosion hazard as well. Rader Rader soils are on low ridges that meander through the low areas. They are moderately well drained soils with low surface runoff, very slow permeability, and they have a high water capacity. There is a slight water erosion hazard for these soils. Included with this soil in mapping are areas of Axtell, Raino, and Styx soils.	The soils are used mainly as pasture and wildlife habitat and are moderately suited to use as cropland. Leaving crop residue on or near the surface helps to reduce soil erosion and maintain organic matter content. Suitability is poor for most urban uses and moderate for most recreational uses. The main limitations are wetness, very slow permeability, and potential for shrinking and swelling with changes in moisture.
Dutek loamy fine sand (DuC)	Deep, gently sloping to strongly sloping (1 to 8 percent) and well drained on broad uplands and high stream terraces. Moderate permeability and moderately available water capacity result in slow runoff. Water erosion is therefore a moderate hazard, and soil blowing is a sever hazard if the soil is left bare. Surface layer: pale brown loamy fine sand approximately 4 inches (10 centimeters) thick. Upper subsoil (5 to 31 inches [13 to 79 centimeters]): light yellowish brown loamy fine sand. Middle subsoil (32 to 51 inches [81 to 130 centimeters]): yellowish red sandy clay loam. Substratum (52 to 84 inches [132 to 213 centimeters]): reddish yellow fine sandy loam in upper part and very pale brown loamy fine sand in the lower part. Included with this soil in mapping are areas of Padina and Silstid soils.	Used as pasture or hayland and also as rangeland. This soil is well suited for urban uses, but is generally not used for crops due to droughtiness and erosion hazards.

Table 6.5-1. Predominant Soil Types, Characteristics, and Uses in the Proposed Power Plant and Sequestration Sites and Related Corridors

Soil Type	Characteristics	Uses
Edge fine sandy loam, 1 to 5 percent slopes (EgB)	Moderately well drained soils formed on broad interstream divides with smooth or slightly convex surfaces. The slopes range from 1 to 5 percent the potential for surface runoff is medium to high and permeability is very slow. The hazard for water erosion is moderate. Included with this soil in mapping are small areas of Crockett, Gasil, Silstid, and Tabor soils. Overseeding legumes such as vetch, singletary peas, arrowleaf clover, and bermudagrass helps to reduce erosion, lengthens the grazing season, and increases soil fertility by adding nitrogen. Applications of lime and a complete fertilizer are needed for optimum grass production.	Used mainly as pasture. It is poor for cropland because of the hazard of erosion. However, leaving crop residue on or near the surface aids in water infiltration, and helps to reduce soil erosion and maintain organic matter content. Terraces and contour farming are needed to control runoff and reduce erosion for these soils. Moderately suited to growing native grasses, and is well suited to wildlife habitat. Suitability is poor for most urban uses, but well suited to most recreational uses. The main limitations are very slow permeability and the potential for shrinking and swelling with changes in moisture.
Edge fine sandy loam, 5 to 12 percent slopes (EgE)	Well drained soils formed on upland side slopes with surfaces that are plane to slightly convex and generally follow along drainageways. Slopes range from 5 to 12 percent potential for surface runoff is very high, permeability is very slow, and the available water capacity is moderate. This combination creates a severe water erosion hazard. Included with this soil in mapping are areas of Axtell, Silawa, and Silstid soils.	Used mainly as pasture and wildlife habitat. It is poorly suited to growing pasture grasses, but is moderately suited to growing native grasses. It is moderately suited to wildlife habitat. This soil is not suitable for cropland because of slope and the hazard of water erosion. Suitability is poor for most urban and recreational uses. Main limitations are low strength, very slow permeability, corrosivity to uncoated steel, slope, and the potential for shrinking and swelling with changes in moisture.
Gasil fine sandy loam (GfB)	Well drained soils formed on upland interstream divides that have plane or slightly convex surfaces. Slopes range from 1 to 5 percent potential for surface runoff is low and permeability is moderate. The hazard of water erosion is moderate. Included with this soil in mapping are areas of Edge, Rader, Silstid, and Tabor soils.	Used mainly as pasture. Overseeding legumes into the bermudagrass lengthens the grazing season and increases soil fertility by adding nitrogen. Applications of a complete fertilizer are needed for optimum grass production. Applications of lime are needed in some areas, especially where a high rate of fertilizer is applied. This soil is moderately suitable for cropland. Leaving crop residue on or near the surface helps to reduce soil erosion and maintain organic matter content. Moderately suited to growing native grasses, well suited for wildlife habitat, and well suited for most urban and recreational uses.

Table 6.5-1. Predominant Soil Types, Characteristics, and Uses in the Proposed Power Plant and Sequestration Sites and Related Corridors

Soil Type	Characteristics	Uses
Gladewater clay, frequently flooded (Gh)	This nearly level soil is on the flood plains of the Trinity River and its larger tributaries. The surfaces are mainly smooth or slightly concave. Flooding generally occurs once or twice a year from November through May for a period of a few days to a week. Slopes range from 0 to 1 percent. This poorly drained soil has low surface runoff, very slow permeability, and high available water capacity. The water-erosion hazard is slight and the water table is generally within a depth of 2 feet (0.6 meters) during the winter and spring. Included with this soil in mapping are small areas of Kaufman, Nahatche, Pluck, and Whitesboro soils.	This Gladewater soil is used mainly as pasture and wildlife habitat. This soil is not suitable for cropland and poorly suited to growing native grasses because of the hazard of flooding. Suitability is poor for most urban and recreational uses because of wetness, the hazard of flooding, and the potential for shrinking and swelling with changes in moisture.
Hatliff fine sandy loam (Ha)	Deep, nearly level, and moderately well drained on bottom lands. Slopes are 0 to 1 percent. This soil is subject to flooding more than once every 2 years. Permeability is moderately rapid. The available water capacity is low, but the soil is saturated with water for periods of a few days to a few weeks in winter and early in spring in most years. Runoff is slow. A high water table is within 2 feet (0.6 meters) of the surface during winter. Included with this soil in mapping are areas of Nahatche and Nugent soils. Nahatche soils are in positions similar to those of the Hatliff soil and they have a fine loamy control section. Nugent soils are in slightly higher positions and are sandy throughout the profile.	Primarily used as woodland, and moderately suited for use as pasture or hayland. It can be used in some areas as rangeland, and is poorly suited to crop production and urban uses.
Hearne fine sandy loam (HeB)	Deep, gently sloping (1 to 5 percent), and well drained on ridgetops on uplands. Slow permeability and moderately available water capacity result in medium runoff and a severe risk of a water erosion hazard. Included with this soil in mapping are areas of Marquez, Padina, Robco, and Silstid soils.	Primarily used as pasture or hayland, also being used as rangeland. It is limited in its use for urban purposes, and is generally not used for crop production due to the severe hazard of erosion and the droughtiness.
Hearne fine sandy loam (HeE)	Strongly to moderately steep, and normally occurs on upland side slopes. The surfaces are plane to slightly convex with slopes ranging from 5 to 15 percent. This soil is well drained and available water capacity is moderate, but due to slow permeability, surface runoff is high and the water-erosion hazard is severe. Included in this soil mapping unit are small areas of Edge and Silstid soils.	Primarily used as pasture and wildlife habitat and is mostly unsuitable for any other uses other than as recreational land.

Table 6.5-1. Predominant Soil Types, Characteristics, and Uses in the Proposed Power Plant and Sequestration Sites and Related Corridors

Soil Type	Characteristics	Uses
Hearne fine sandy loam, stony (HsE)	Strongly sloping to moderately steep (5 to 20 percent), and well drained on long, narrow knolls and upper side slopes on uplands. Stones and boulders of sandstone cover 5 to 10 percent of the surface. Slow permeability and low available water capacity result in rapid runoff and a severe risk of a water erosion hazard. Included with this soil in mapping are some areas of Hearne soils that do not have stones on the surface or in the surface layer and a soil similar to Hearne soil except it has gravel on the surface or in the surface layer.	Despite its poor suitability for the use, Hearne soil is mainly used as rangeland. This soil is not suited to crop or pasture production and has many limitations for urban uses.
Kaufman clay, frequently flooded (Kc)	Nearly level soil on floodplains that are unprotected from flooding. This soil is covered by shallow, slow-moving floodwater at least once each year. Flooding is usually during the spring and lasts five to 60 days. Included in this soil in mapping are areas of Trinity soils and of Kaufman soils.	Used for pasture. It is not suitable for cultivation.
Kaufman clay, frequently flooded (Kd)	This nearly level soil is located on flood plains of the Trinity River and its larger tributaries. Flooding occurs once or twice in most years, most likely from November through May. Slopes are less than 1 percent. These somewhat poorly drained soils have low surface runoff, very slow permeability, high water capacity, and a slight water erosion hazard. Included with this soil in mapping are small areas of Gladewater, Nahatche, Trinity, and Whitesborosoils.	This Kaufman soil is used mainly as pasture and wildlife habitat. Wetness and the clayey texture limit equipment use during certain times of the year and cause severe seedling mortality and plant competition. Suitability is poor for most urban and recreational uses. Flooding occurs frequently. The soil shrinks and swells with changes in moisture and has a clayey surface layer.
Keechi loamy fine sand (Kh)	Located on nearly level floodplains of streams that drain watersheds. The surfaces are mainly concave. Flooding occurs once or twice in most years for a period of one to five days, mainly from December through May. Slopes range from 0 to 1 percent. This soil is poorly drained with slow permeability and moderate available water capacity, resulting in low surface runoff and a slight risk for a water erosion hazard. A water table is generally within a depth of 12 inches (30 centimeters) during the winter and spring. Included with this soil in mapping are areas of Hatliff, Leagueville, Nahatche, and Pluck soils. The Hatliff soils are on natural levees along stream channels. The Leagueville soils are on foot slopes of adjacent uplands. The Nahatche soils are in slightly higher positions on the landscape. The Pluck soils are in positions similar to those of the Keechi soil.	Primarily used as wildlife habitat and is moderately suited for this purpose along with pastures. It is poorly suited to woodland and urban uses. This soil is not suitable to cropland due to flooding.

Table 6.5-1. Predominant Soil Types, Characteristics, and Uses in the Proposed Power Plant and Sequestration Sites and Related Corridors

Soil Type	Characteristics	Uses
Kirvin fine sandy loam (KrB)	Gently sloping soil located on upland interstream divides. The surfaces are plane to slightly convex. This soil is well drained with moderately slow permeability and moderate available water capacity, resulting in low surface runoff and a moderate risk for a water erosion hazard. Included with this soil in mapping are small areas of Cuthbert, Oakwood, and Wolfpen soils. The Cuthbert soils are in positions on the landscape similar to those of the Kirvin soils. The Oakwood soils are in areas that have lower and smoother slopes. The Wolfpen soils are in slightly higher positions on the landscape. Also included is a Kirvin soil that has a gravelly fine, sandy loam surface layer. This soil is in higher, more convex areas.	Used mainly as pasture, but is well suited to woodland, wildlife habitat, urban, and recreational uses. This soil is poorly suited to growing native grasses, and is moderately suitable for cropland.
Kirvin gravelly fine sandy loam (KyC)	Gently sloping to strongly sloping (2 to 8 percent) soil on uplands. The surfaces are mainly convex. Areas are mainly elliptical, occupying narrow interstream divides or low sloping knolls. This soil is well drained with moderately slow permeability and moderate available water capacity, resulting in low to medium surface runoff and a slight risk of a water erosion hazard. Included with this soil in mapping are small areas of Cuthbert, Oakwood, and Wolfpen soils. The Cuthbert soils are in positions on the landscape similar to those of the Kirvin soils. The Oakwood soils are in areas that have lower, smoother slopes. The Wolfpen soils are in slightly higher positions on the landscape. Also included are small areas of a Kirvin soil that has more than 35 percent gravel in the surface layer and a Kirvin soil that has as much as 5 percent of the surface covered by stones. The very gravelly and stony Kirvin soils are along the highest parts of narrow ridges.	Used mainly as pasture and wildlife habitat. The soil is poorly suited to cropland, growing native grasses, and has moderate suitability for most urban uses. The soil is well suited to woodland and wildlife habitat.
Marquez gravelly fine sandy loam (MrB)	Gently sloping (1 to 5 percent), and well drained on small knobs and ridges on uplands. Slow permeability and moderate available water capacity result in medium to rapid runoff and a severe risk for a water erosion hazard. Included with this soil in mapping are areas of Gasil and Hearne soils. Gasil soils are in slightly lower positions on the landscape than the Marquez soil. Hearne soils are on the steeper side slopes.	Primarily used as pasture or hayland and alternatively used for rangeland to which it is well suited. Generally not used for crops due to the gravelly surface layer and the hazard of erosion. It is also limited in its use for urban purposes.

Table 6.5-1. Predominant Soil Types, Characteristics, and Uses in the Proposed Power Plant and Sequestration Sites and Related Corridors

Soil Type	Characteristics	Uses
Marquez very fine sandy loam (MkB)	Deep, gently sloping (1 to 5 percent), and well drained on broad ridges and side slopes on uplands. Slow permeability, and moderately available water capacity result in medium to rapid runoff with a severe risk of a water erosion hazard. Included with this soil in mapping are areas of Gasil and Hearne soils. Gasil soils are in slightly lower positions on the landscape than the Marquez soil. Hearne soils are on steeper side slopes.	Primarily used as pasture or hayland and alternatively used for rangeland to which it is well suited. The Marquez soil is generally not used for crops due to droughtiness and the severe hazard of erosion, but crops such as corn, cotton, and grain sorghum are suitable. It is also limited in its use for urban purposes.
Nahatche clay loam, frequently flooded	Nearly level soil on flood plains of large creeks. Flooding occurs one to three times in most years, mainly from November through May, for a period of one to four days after heavy rains. Slopes range from 0 to 1 percent. This soil is somewhat poorly drained with moderate permeability and high available water capacity, resulting in negligible surface runoff and a slight risk of a water erosion hazard. A water table is generally within a depth of 3 feet (1 meter) during the winter and spring. Included with this soil in mapping are areas of Hatliff and Pluck soils. The Hatliff soils are on natural levees along stream channels and on alluvial fans adjacent to surrounding uplands. The Pluck soils are in depressions and old sloughs. Also included is a soil similar to the Nahatche soil, except that it has a coarser texture.	Used mainly as pasture and wildlife habitat, and not suitable for cropland due to flooding and wetness. This soil is well suited to wildlife habitat, moderately suited to growing native grasses and producing hardwood timber, and poorly suited for most urban and recreational uses.

Table 6.5-1. Predominant Soil Types, Characteristics, and Uses in the Proposed Power Plant and Sequestration Sites and Related Corridors

Soil Type	Characteristics	Uses
Nahatche-Hatliff Association, frequently flooded (NH)	Nearly level, loamy soils on the floodplains of local streams. They are characterized by frequent flooding, mainly between November and May. Slopes range from 0 to 1 percent. The Nahatche soils occupy backwater areas of floodplains. Hatliff soils are located on natural levees along stream channels, alluvial fans, and pointbars. Included with these soils in mapping are small areas of Pluck soils in old sloughs and depressions. Also included is a soil closely similar to the Hatliff soil, except it has a coarser texture. Nahatche Poorly drained, but due to the moderate permeability and high available water capacity, surface runoff is negligible and the risk for water-erosion hazard is slight. A water table is generally within a depth of 12 inches (30 centimeters) during winter and spring. Hatliff Soils are moderately well drained with moderately rapid permeability and moderately available water capacity, resulting in negligible surface runoff and a slight hazard for water-erosion. A water table is generally within a depth of 2 feet (0.6 meters) during the winter.	Not suitable for cropland or urban and recreational uses due to flooding, but are moderately suited to growing native grasses and well suited to wildlife habitat.
Oakwood fine sandy loam (OkB)	Gently sloping (1 to 5 percent) soil on broad upland divides. The surfaces are smooth or slightly convex. This soil is moderately well drained with moderately slow permeability and high available water capacity, resulting in low surface runoff and a moderate risk of a water erosion hazard. Included with this soil in mapping are small areas of Kirvin, Raino, and Wolfpen soils. The Kirvin and Wolfpen soils are in slightly higher positions on the landscape. The Raino soils are in depressions and on lower foot slopes.	Used mainly as pasture and is moderately suitable for cropland and growing native grasses. It is well suited to woodlands, wildlife habitat, and most urban and recreational uses.

Table 6.5-1. Predominant Soil Types, Characteristics, and Uses in the Proposed Power Plant and Sequestration Sites and Related Corridors

Soil Type	Characteristics	Uses
Padina loamy fine sand (PaB)	Well drained soils formed on uplands with mainly smooth or convex surfaces. Slopes range from 1 to 5 percent potential for surface runoff is very low and permeability is rapid in the surface and subsurface layers and moderate in the subsoil. The available water capacity is low and the hazard of water erosion is moderate. A perched water table is generally within a depth of 5 feet (1.5 meters) during the winter. Included with this soil in mapping are small areas of Arenosa, Robco, and Silstid soils. The Arenosa and Silstid soils are in positions on the landscape similar to those of the Padina soils, and the Robco soils are in concave depressions and at the heads of drainageways. Also included is a soil closely similar to the Padina soil, except it is very strongly acidic in the subsoil. The included soils make up less than 20 percent of the map unit (FG Alliance, 2006c).	Used mainly as pasture, and is moderately suited to pastures of Coastal Bermudagrass and Lovegrass. This soil is moderately suited to crops such as corn, peas, and watermelons. Leaving crop residue on or near the surface helps to reduce erosion and maintain organic matter content. Applications of lime and a complete fertilizer are needed for optimum yields. It is moderately suited to growing native grasses, poorly suited for wildlife habitat, and moderately suited for most urban and recreational uses. Overseeding legumes such as vetch or Arrowleaf Clover into the pasture grass, lengthens the grazing season and increases soil fertility by adding nitrogen. Applications of lime and a complete fertilizer are needed to increase grass production (FG Alliance, 2006c).

Table 6.5-1. Predominant Soil Types, Characteristics, and Uses in the Proposed Power Plant and Sequestration Sites and Related Corridors

Soil Type	Characteristics	Uses
Padina loamy fine sand (PaC)	Very deep, well drained soils formed on uplands and high terraces with smooth or convex surfaces. Slopes range from 1 to 5 percent permeability, is rapid in the surface and subsurface, moderate in the subsoil, and available water capacity is low and runoff is negligible. The water erosion hazard is moderate and the shrink-swell potential is very low. There is no water table within a depth of 6 feet (1.8 meters) and there is no bedrock within a depth of 6 feet (1.8 meters). Included with this soil in mapping are small areas of Edge, Gasil, Personville, Robco, Silawa, Silstid, and Styx soils.	Used mainly as rangeland and is moderately suited to this use with the main limitations being the very low natural fertility, and the low available water capacity which causes droughty conditions to occur more readily than in most other soils. Moderately suited to pasture and hayland grasses. The most limiting features are very low natural fertility and low available water capacity. Fertilizer and controlled grazing are needed for improved yields of adapted grasses such as Coastal and common Bermudagrass. Some pastures are overseeded with legumes such as clovers and Singletary peas. This adds nitrogen to the soil and provides early grazing in the spring. Lime may be needed to decrease soil acidity. Generally not used for crops because of droughtiness and the hazard of water erosion. However, it is moderately suited to peanuts, watermelons, peas, and small grains. Soil blowing (erosion) is a hazard if this soil is cropped. Leaving crop residue on or near the surface helps control both wind and water erosion, conserves moisture, maintains fertility, and maintains organic matter. Cover crops, high residue crops, and green manure crops reduce erosion and help maintain fertility. Crops respond well to fertilization. Moderately suited to most urban and recreational uses. The main limiting features are the sandy surface layer, droughtiness, sidewall sloughing, seepage, and soil blowing. Good design and proper installation can reduce the effects of these limitations (FG Alliance, 2006c).
Padina loamy fine sand (PaD)	Deep, gently sloping to strongly sloping (8 to 15 percent), and moderately well drained in broad, smooth to convex areas on uplands. Permeability is moderately slow, and the available water capacity is low. A perched high water table is present for short periods after heavy rainfall. Runoff is slow and water erosion is a moderate hazard. Soil blowing is a hazard in bare areas and on construction sites. Included in this mapping are areas of Arenosa, Dutek, Hearne, Jedd, Robco, and Silstid soils.	Mainly used as rangeland and is also used as pasture or hayland. It is not well suited to crop production due to severe hazard of erosion and steepness of slope.

Table 6.5-1. Predominant Soil Types, Characteristics, and Uses in the Proposed Power Plant and Sequestration Sites and Related Corridors

Soil Type	Characteristics	Uses
Pickton loamy fine sand (PkC)	Gently sloping to moderately sloping (1 to 8 percent) soil on broad upland divides. The surfaces are mainly convex. This soil is well drained with rapid permeability in the surface layers and moderate in the subsoil layers. These factors, combined with the low available water capacity results in low surface runoff and a moderate risk of a water erosion hazard. A water table is generally within a depth of 5 feet (1.5 meters) during the winter. Included with this soil in mapping are small areas of Leagueville, Tonkawa, and Wolfpen soils. The Leagueville soils are in concave depressions and at the heads of drainageways. The Tonkawa and Wolfpen soils are in positions on the landscape similar to those of the Pickton soils.	Used mainly as pasture, and is poorly suited to growing native grasses. It is moderately suited to cropland, woodland use, and most urban and recreational uses.
Pickton loamy fine sand (PkE)	Strongly sloping to moderately steep (8 to 15 percent) soil is on upland side slopes. The surfaces are mainly convex. This soil is well drained with moderate permeability and low available water capacity, resulting in low surface runoff and a severe risk of a water erosion hazard. A water table is generally within a depth of 5 feet (1.5 meters) during the winter. Included with this soil in mapping are small areas of Cuthbert, Tonkawa, and Wolfpen soils. The Cuthbert soils are on steeper upper slopes. The Wolfpen and Tonkawa soils are in positions on the landscape similar to those of the Pickton soils.	Used mainly as pasture and is moderately suited to woodland use. It is poorly suited to cropland, growing native grasses, and most urban and recreational uses.
Pluck loam, frequently flooded (Pu)	Nearly level soil located on flood plains of streams with surfaces that are mainly concave. Flooding occurs one to four times in most years, generally from November through May, for a period of one to six days after heavy rains. Slopes are less than 1 percent. This poorly drained soil has negligible surface runoff, moderate permeability and water capacity and a slight water-erosion hazard. A water table is generally at or near the surface during the winter and early spring. Included in mapping are small areas of Gladewater, Keechi, and Nahatche soils.	Used mainly as pasture and wildlife habitat. This soil is moderately suited to wildlife habitat and not suitable for cropland because of flooding. Suitability is poor for most urban and recreational uses because of flooding and wetness.
Rader fine sandy loam (RaB)	Nearly level to gently sloping (0 to 3 percent) and is found on stream terraces. The surfaces are mainly smooth. The soil is well drained with slow permeability and high water capacity, resulting in low to medium surface runoff and a slight risk for water erosion. A perched water table is generally within a depth of 3 feet (1 meter) during the winter. Included within this soil mapping unit are small areas of Derly, Oakwood, and Styx soils.	Used primarily as pasture, and is moderately suitable for cropland, growing native grasses, urban uses, and recreational development.

Table 6.5-1. Predominant Soil Types, Characteristics, and Uses in the Proposed Power Plant and Sequestration Sites and Related Corridors

Soil Type	Characteristics	Uses
Raino fine sandy loam, 0 to 2 percent slopes (RnA)	Nearly level to gently sloping soil located on upland foot slopes and saddles. They have surfaces that are smooth or slightly concave. These moderately well drained soils have low surface runoff, very slow permeability, and a low water capacity. The water-erosion hazard is slight and a perched water table is generally within a depth of 3 feet (1 meter) during the winter and spring. Included with this soil in mapping are small areas of Derly, Oakwood, Rader, and Wolfpen soils.	Used mainly as pasture, although applications of lime and a complete fertilizer are needed for optimum grass production. It is moderately suitable for cropland. This soil is well suited to woodland use and for wildlife habitat. The suitability is poor for most urban uses, mainly because of wetness and the potential for shrinking and swelling.
Silawa fine sandy loam (SaB)	Deep, strongly sloping to moderately steep (1 to 5 percent), and moderately well drained on the narrow side slopes and ridge tops on uplands. Moderate permeability and available water capacity result in slow to medium runoff and a moderate risk for a water erosion hazard. Included in this soil mapping are areas of Arenosa, Hearne, and Jedd soils. Arenosa soils are in slightly higher positions on the landscape than the Padina soil. Hearne and Jedd soils are in positions similar to those of the Padina soil. Also included is a soil similar to the Padina soil except the surface layer is fine sand.	Used for rangeland and is well suited for this use. In a few areas, this soil is used for crops and is also well suited to sanitary facilities, dwellings, roads, and streets.
Silawa fine sandy loam (SaD)	Very deep, well drained soils formed on high steam terraces that are mostly convex. Slopes range from 5 to 12 percent surface runoff potential is medium and permeability is moderate. Water capacity is moderate and water erosion hazard is severe. The shrink-swell potential is low. There is no water table within a depth of 6 feet (1.8 meters), and bedrock is not found within a depth of 6 feet (1.8 meters) (Leon County). Included with these mapped soils are small areas of Edge, Lavender, Silstid, and Padina soils.	Used mainly as pasture or rangeland. The most limiting features are the moderate available water capacity, medium runoff, and severe erosion hazard. A complete fertilizer and controlled grazing are needed for improved yields of adapted grasses such as Coastal Bermudagrass and kleingrass. Some pastures are overseeded with legumes such as clovers and Singletary peas. This adds nitrogen to the soil and provides early grazing in the spring. Lime may be needed to decrease soil acidity. Moderate available water capacity, medium runoff, and severe erosion hazard are limiting features for rangeland on these soils. Moderately suited to urban and recreational uses. The limiting features are slope and seepage. Good design and proper installation can reduce the effects of these limitations.

Table 6.5-1. Predominant Soil Types, Characteristics, and Uses in the Proposed Power Plant and Sequestration Sites and Related Corridors

Soil Type	Characteristics	Uses
Silawa fine sandy loam (SaE)	Well drained soil found on side slopes of high stream terraces, and the surfaces are slightly convex. Slopes range from 5 to 12 percent, runoff potential is medium, permeability is moderate, and the available water capacity is moderate. The hazard of water erosion is severe.	Used mainly as pasture and wildlife habitat. It is moderately suited to pastures especially with the practice of overseeding legumes into the Coastal Bermudagrass. This practice lengthens the grazing season and increases soil fertility by adding nitrogen. Applications of lime and a complete fertilizer are needed to increase grass production. The soil is moderately suited to wildlife habitat. Not suitable for cropland because of slope and the hazard of erosion. It is moderately suited to growing native grasses. Suitability is moderate for most urban and recreational uses, with the main limitation being slope.
Silstid loamy fine sand (SdB)	Well drained soils formed in broad areas on uplands. Slopes range from 1 to 5 percent surface runoff is slow, permeability is moderate and available water capacity is moderate. Water erosion hazard is moderate and soil blowing is a hazard in bare areas and on construction sites. Included with this soil in mapping are areas of Dutek, Gasil, Padina, and Robco soils.	Used mainly as pasture or hayland. The main limitation for use as pasture or hayland is droughtiness. Pastures require light applications of fertilizer and lime at frequent intervals for high production. Legumes, such as vetch and Singletary peas, overseeded into the grass prolong the grazing season and improve the soil. Used as rangeland with the main limitation being droughtiness. Generally is not used for crops because of droughtiness and the hazard of erosion. This soil, however, is suited to peanuts, watermelons, peas, and sweet potatoes. Fertilizer and lime are essential for good yields. Cover crops, high residue crops, and green manure crops help control erosion and maintain fertility. This soil is well suited to most urban uses.

Table 6.5-1. Predominant Soil Types, Characteristics, and Uses in the Proposed Power Plant and Sequestration Sites and Related Corridors

Soil Type	Characteristics	Uses
Silstid loamy fine sand (SsB)	Well drained soils formed on gently sloping uplands with smooth or slightly convex surfaces. Slopes range from 1 to 5 percent, so surface runoff is very low; and permeability is rapid in the surface and subsurface layers and moderate in the subsoil. The available water capacity and the hazard of water erosion are both moderate. A water table is generally within a depth of 5 feet (1.5 meters) during the winter and spring.	Used mainly as pasture. Overseeding legumes, such as vetch or Arrowleaf Clover, into the Coastal Bermudagrass lengthens the grazing season and increases soil fertility by adding nitrogen. Applications of lime and a complete fertilizer are needed to increase grass production. Moderately suited to growing crops such as corn, peas, and watermelons. Leaving crop residue on or near the surface helps to reduce erosion and maintain organic matter content. Applications of lime and a complete fertilizer are needed for optimum yields. Moderately suited to growing native grasses. It is poorly suited to wildlife habitat, well suited to most urban uses, and moderately suited to most recreational uses. The sandy surface layer is the main limitation (FG Alliance, 2006c).
Silstid loamy fine sand (SsD)	Well drained soils formed on upland side slopes with slightly convex surfaces. Slopes range from 5 to 8 percent and surface runoff is low. Permeability is rapid in the surface and subsurface layers and moderate in the subsoil. The available water capacity is moderate and the hazard of water erosion is moderate. A water table is generally within a depth of 5 feet (1.5 meters) during the winter and spring (for Limestone County).	Used mainly as pasture, especially with the practice of overseeding legumes into the Coastal Bermudagrass. This practice lengthens the grazing season and increases soil fertility by adding nitrogen. Applications of lime and a complete fertilizer are needed to increase grass production. Moderately suited to growing crops. Leaving crop residue on or near the surface helps to reduce erosion and maintain organic matter content. Applications of lime and a complete fertilizer are needed to increase yields. Moderately suited to growing native grasses and it is moderately suited to wildlife habitat. It is well suited to most urban uses and moderately suited to most recreational uses. The sandy surface layer and slope are the main limitations (FG Alliance, 2006c).
Styx loamy fine sand, 0 to 3 percent slopes (StB)	This nearly level to gently sloping soil is on stream terraces. These well drained soils have negligible surface runoff, moderately rapid to moderate permeability and a moderate available water capacity. The water erosion hazard is slight and a perched water table is generally within a depth of 3.5 to 4.5 feet (1.1 to 1.4 meters) during the winter and spring. The surfaces are smooth or slightly convex. Included with this soil in mapping are small areas of Bienville, Derly, and Rader soils.	This Styx soil is used mainly as pasture. Applications of lime and a complete fertilizer are needed to increase grass production. This soil is moderately suited to growing crops such as corn, peas, and watermelons. Leaving crop residue on or near the surface helps to reduce erosion and maintain organic matter content. It is moderately suited to wildlife habitat. This soil is also well suited to most urban uses, and moderately suited to most recreational uses.

Table 6.5-1. Predominant Soil Types, Characteristics, and Uses in the Proposed Power Plant and Sequestration Sites and Related Corridors

Soil Type	Characteristics	Uses
Tabor fine sandy loam (TaB)	Gently sloping soil (1 to 3 percent) located on broad uplands and has mainly smooth surfaces. Moderately well drained with very slow permeability and high water capacity, resulting in medium surface runoff and a moderate risk for water erosion. Included with this soil in mapping are areas of Edge, Gasil, Lufkin, and Silstid soils.	Used mainly as pasture, and is well suited to growing native grasses, while being poorly suited for most urban uses. Moderately suited to growing cotton, grain sorghum, small grains, and corn.
Tonkawa fine sand, 1 to 8 percent slopes (ToC)	Gently sloping to moderately sloping soil located on uplands with surfaces that are slightly convex. These excessively drained soils have negligible to very low surface runoff, rapid permeability, a slight water erosion hazard and low available water capacity. Included with this soil in mapping are areas of Leagueville and Pickton soils.	Used mainly as pasture. This soil is not suitable for cropland due to excessive drainage and low available water capacity. Leaving crop residue on or near the surface would help to reduce erosion, increase organic matter content, and improve the water holding capacity. It is poorly suited to wildlife habitat and growing native grasses due to droughtiness and available water capacity. Suitability is moderate for most urban uses and is poor for most recreational uses due to the sandy texture.
Trinity clay (Tr)	Usually covered by shallow slow-moving floodwater at least once each year, but flooding lasts only a short time. Included with this soil in mapping are small areas of Kaufman soils on lower parts of the flood plain.	Most areas are in hardwood timber and are used mainly for pasture. This clayey soil is difficult to work. Flooding is a hazard if the soil is not protected by levees.
Wolfpen loamy fine sand (WoB)	Gently sloping (1 to 5 percent) soil on uplands and the surfaces are slightly convex. This soil is well drained with rapid permeability in the surface and subsurface layers and moderate in the subsoil. These factors, combined with the moderate available water capacity, result in very low surface runoff and a moderate risk of a water erosion hazard. A water table is generally within a depth of 5 feet (1.5 meters) during the winter and early spring. Included with this soil in mapping are areas of Kirvin, Leagueville, Oakwood, and Pickton soils. The Kirvin soils are in slightly higher positions on the landscape. The Leagueville soils are in depressions and on toe slopes and foot slopes. The Oakwood soils are in areas that have lower, smoother slopes. The Pickton soils are in positions on the landscape similar to those of the Wolfpen soil.	Used mainly as pasture, and is well suited to most urban and recreation uses. It is moderately suited to cropland, woodland, and growing native grasses.

Table 6.5-1. Predominant Soil Types, Characteristics, and Uses in the Proposed Power Plant and Sequestration Sites and Related Corridors

Soil Type	Characteristics	Uses
Wolfpen loamy fine sand (WoE)	Strongly sloping (5 to 15 percent) to moderately steep soil on uplands. The surfaces are mainly convex. This soil is well drained with moderate permeability and moderate available water capacity, resulting in low surface runoff and a severe risk of a water erosion hazard. A water table is generally within a depth of 5 feet (1.5 meters) during the winter and early spring. Included with this soil in mapping are small areas of Cuthbert and Pickton soils. The Cuthbert soils are on higher and steeper slopes. The Pickton soils are in positions on the landscape similar to those of the Wolfpen soil.	Used mainly as pasture, and is not suitable for cropland or most urban uses. It is well suited for use as woodland, and moderately suited to growing native grasses.

Source: FG Alliance, 2006c.

Power Plant Site

Predominant soil types within the proposed power plant site include Gasil fine sandy loam (GfB), Padina loamy fine sand (PaB, PaC), Silawa fine sandy loam (SaD, SaE), and Silsted loamy fine sand (SdB, SsB) (FG Alliance, 2006c) (see Table 6.5-1).

A Phase I ESA was performed on the proposed power plant site in April of 2006 (Horizon Environmental Services, 2006). Areas were observed on the proposed site that indicated past surface spillage of petroleum-related substances resulting in stained soils. Metal storage sheds, diesel storage tanks, 55-gallon (208-liter) drums, waste/debris piles, tank trucks, chemical storage areas, storage areas for farm implements, and pipeline easements are on the proposed power plant site. The Phase I ESA concluded that any resulting contamination was not significant with respect to siting another industrial facility at this location. Further soil testing was recommended before site construction to determine if any soil contamination exceeds the Texas Commission on Environmental Quality Risk Reduction Standard for industrial sites (FG Alliance, 2006c).

Sequestration Site

Segment A-C

Predominant soils found along this segment include Padina loamy fine sand, 1 to 5 percent slopes (PaB); Edge fine sandy loam, 1 to 5 percent slopes (EgB); Edge fine sandy loam, 5 to 12 percent slopes (EgE); Gasil fine sandy loam, 1 to 5 percent slopes (GfB); Silstid loamy fine sand, 1 to 3 percent slopes (SsB); Silstid loamy fine sand, 3 to 8 percent slopes (SsD); Hearne fine sandy loam, 5 to 15 percent slopes (HeE); Nahatche-Hatliff association, frequently flooded (NH); Rader fine sandy loam, 0 to 3 percent slopes (RaB); and Tabor fine sandy loam, 1 to 3 percent slopes (TaB). Characteristics and uses of the remaining soils are presented in Table 6.5-1.

Segment B-C

Segment B-C of the proposed CO_2 pipeline corridor lies within Freestone and Leon counties. The predominant soils found in the area include Arenosa fine sand, 1 to 8 percent slopes (ArC); Axtell fine sandy loam, 1 to 5 percent slopes (AxB); Dutek loamy fine sand, 1 to 8 percent slopes (DuC); Hatliff fine sandy loam frequently flooded (Ha); Hearne fine sandy loam, 1 to 5 percent slopes (HeB); Hearne fine sandy loam, 5 to 20 percent slopes, stony (HsE); Gasil fine sandy loam, 1 to 5 percent slopes (GfB);

Marquez very fine sandy loam, 1 to 5 percent slopes (MkB); Marquez gravelly fine sandy loam, 1 to 5 percent slopes (MrB); Nahatche-Hatliff association, frequently flooded (NH); Padina loamy fine sand, 1 to 5 percent slopes (PaB); Padina loamy fine sand, 1 to 8 percent slopes (PaC); Padina loamy fine sand, 8 to 15 percent slopes (PaD); Rader fine sandy loam, 1 to 3 percent slopes (RaB); Silawa fine sandy loam, 1 to 5 percent slopes (SaB); Silawa fine sandy loam, 5 to 8 percent slopes (SaD); Silawa fine sandy loam, 5 to 12 percent slopes (SaE); Silstid loamy fine sand, 1 to 5 percent slopes (SdB); Silstid loamy fine sand, 1 to 5 percent slopes (SsB); and Silstid loamy fine sand, 5 to 8 percent slopes (SsD). Characteristics and uses of the soils are presented in Table 6.5-1.

Segment C-D

Segment C-D of the proposed CO_2 pipeline corridor lies entirely within Freestone County. The predominant soils found in the mapping area include Arenosa fine sand, 1 to 8 percent slopes (ArC); Cuthbert fine sandy loam, 5 to 15 percent slopes (CtE); Cuthbert gravelly fine sandy loam, 15 to 30 percent slopes (CvF); Cuthbert soils, graded, 5 to 15 percent slopes (CxE); Cuthbert gravelly fine sandy loam, 15 to 40 percent slopes, very stony (CzG); Gasil fine sandy loam, 1 to 5 percent slopes (GfB); Hearne fine sandy loam, 5 to 15 percent slopes (HeE); Keechi loamy fine sand, frequently flooded (Kh); Kirvin fine sandy loam, 1 to 5 percent slopes (KrB); Kirvin gravelly fine sandy loam, 2 to 8 percent slopes (KyC); Nahatche clay loam, frequently flooded (Na); Nahatche-Hatliff association, frequently flooded (NH); Oakwood fine sandy loam, 1 to 5 percent slopes (OkB); Padina loamy fine sand, 1 to 5 percent slopes (PaB); Pickton loamy fine sand, 1 to 8 percent slopes (PkC); Pickton loamy fine sand, 8 to 15 percent slopes (PkE); Pluck loam, frequently flooded (Pu); Raino fine sandy loam, 0 to 2 percent slopes (RnA); Rader fine sandy loam, 0 to 3 percent slopes (RaB); Silawa fine sandy loam, 5 to 12 percent slopes (SaE); Silstid loamy fine sand, 1 to 5 percent slopes (SsB); Silstid loamy fine sand, 5 to 8 percent slopes (SsD); Tonkawa fine sand, 1 to 8 percent slopes (ToC); Wolfpen loamy fine sand, 1 to 5 percent slopes (WoB); and Wolfpen loamy fine sand, 5 to 15 percent slopes (WoE). Characteristics and uses of the soils are presented in Table 6.5-1.

Segment D-E

Segment D-E is no longer being evaluated for this EIS, therefore, soils are not addressed for this segment.

Segment D-F

Predominant soils along this segment include Cuthbert fine sandy loam, 5 to 15 percent slopes (CtE); Cuthbert gravelly fine sandy loam, 15 to 30 percent slopes (CvF); Cuthbert soils, graded, 5 to 15 percent slopes (CxE); Cuthbert gravelly fine sandy loam, 15 to 40 percent slopes, very stony (CzG); Keechi loamy fine sand, frequently flooded (Kh); Kirvin fine sandy loam, 1 to 5 percent slopes (KrB); Nahatche-Hatliff association, frequently flooded (NH); Pickton loamy fine sand, 1 to 8 percent slopes (PkC); Pickton loamy fine sand, 8 to 15 percent slopes (PkE); Tonkawa fine sand, 1 to 8 percent slopes (ToC); and Wolfpen loamy fine sand, 5 to 15 percent slopes (WoE). (Table 6.5-1).

Segment F-G

Predominant soils along this segment include Nahatche-Hatliff association, frequently flooded (NH); Rader fine sandy loam, 0 to 3 percent slopes (RaB); Cuthbert fine sandy loam, 5 to 15 percent slopes (CtE); Cuthbert gravelly fine sandy loam, 15 to 40 percent slopes, very stony (CzG); Keechi loamy fine sand, frequently flooded (Kh); Oakwood fine sandy loam, 1 to 5 percent slopes (OkB); Pickton loamy fine sand, 1 to 8 percent slopes (PkC); Pickton loamy fine sand, 8 to 15 percent slopes (PkE); Wolfpen loamy fine sand, 1 to 5 percent slopes (WoB); Wolfpen loamy fine sand, 5 to 15 percent slopes (WoE);

Derly-Rader complex, 0 to 1 percent slopes (DrA); Kaufman clay, frequently flooded (Kd); and Styx loamy fine sand, 0 to 3 percent slopes (StB). (Table 6.5-1).

Segment F-H

Predominant soils along this segment include Nahatche-Hatliff association, frequently flooded (NH); Cuthbert gravelly fine sandy loam, 15 to 40 percent slopes, very stony (CzG); Pickton loamy fine sand, 1 to 8 percent slopes (PkC); Wolfpen loamy fine sand, 5 to 15 percent slopes (WoE); Kaufman clay, frequently flooded (Kd); Gladewater clay, frequently flooded (Gh); Kaufman clay, frequently flooded (Kc); and Trinity clay (Tr) (Table 6.5-1).

Cuthbert gravelly fine sandy loam is described by 15 to 40 percent slopes, very stony (CzG); Nahatche-Hatliff association, frequently flooded (NH); Pickton loamy fine sand, 1 to 8 percent slopes (PkC); and Wolfpen loamy fine sand, 5 to 15 percent slopes (WoE) have been previously provided.

Flooding and shrink swell are hazards to be evaluated in the area of the proposed F-H CO_2 corridor.

Utility Corridors

Water Supply Corridor

Predominant soils found along the proposed water supply pipeline include Padina loamy fine sand, 1 to 5 percent slopes (PaB); Gasil loamy fine sand, 1 to 5 percent slopes (GfB); Padina loamy fine sand, 1 to 5 percent slopes (PaC); Silstid loamy fine sand, 1 to 3 percent slopes (SsB); and Silstid loamy fine sand, 3 to 8 percent slopes (SsD). Descriptions of these soils are presented in Table 6.5-1.

6.5.3 IMPACTS

6.5.3.1 Construction Impacts

Direct impacts that could be caused during construction of the proposed power plant and associated infrastructure include removal of soil, soil-blowing and erosion due to wind and motion of equipment, soil compaction, and change in soil composition. Soil removal disturbs soil properties such as permeability, horizon structure, and vegetation. Soil-blowing could cause the movement of soil, making it unstable as well as unsuitable for vegetation growth. Soil compaction could cause changes in soil characteristics such as permeability, water capacity, surface runoff, root penetration, and water capacity. Indirectly, impacts to soils could result in soil erosion due to runoff and wind, potential decline in nearby surface water quality due to increased sedimentation, potential soil contamination due to spills, and a decrease in biodiversity due to changing soil characteristics. BMPs would be used to minimize impacts (see Section 3.1.5).

Groundwater contamination is unlikely to occur due to the moderately deep level of the water table. During the winter and early spring, many of the soils have a perched water table within a couple of feet of the surface. If a spill were to occur during this time the perched water table could easily be contaminated.

Power Plant Site

Construction at the proposed power plant site would impact up to 200 acres (81 hectares) of soil. Soil impacts would result from construction of the power plant, storage areas, associated processing facilities, research facilities, parking areas, access roads, and the on-site railroad loop. During construction, soil would be removed from areas where the foundations of the structures would be sited. This soil would be placed on a temporary storage site protected from erosion and runoff for reuse as topsoil replacement or as fill. Removing and replacing these soils would likely result in changes to soil composition and characteristics, such as infiltration rate, within the proposed 200-acre (81-hectare) power plant footprint. Soils impacts would be permanent for areas converted into impervious surface areas (e.g., structure, pads, and parking). Temporary soil compaction would occur in areas of temporary road construction and heavy equipment storage, soil-blowing and localized erosion would be likely during construction from equipment movement. Construction-related impacts to soils in areas not converted to impervious surfaces would be temporary and these areas would be restored after construction is completed.

Chemical spills could potentially affect on-site soil. Chemicals commonly used during construction include oils, paints, solvents, lubricants and cement. The quantities of these chemicals expected on-site during construction are small. The use of segregation, storage, labeling, and adequate handling, as well as secondary containment and other spill prevention techniques, could minimize the potential for a spill to occur. Should a spill occur, it would be contained and would not be expected to permanently impact soil characteristics such as pH, porosity, humidity, and texture.

Soils present at the proposed site are abundant throughout the region; therefore, overall impacts would not be adverse. The potential for impacts to prime farmland soil is discussed in Section 6.11.

Sequestration Site

The construction of the injection wells at the proposed sequestration site would result in the removal of up to 10 acres (4 hectares) of soil. Direct impacts would include the removal of soil, soil blowing, and compaction. Indirect impacts would include soil erosion due to runoff and wind, a decline in nearby surface water quality due to increased sedimentation, groundwater contamination due to spills, and a decrease in biodiversity due to changing soil characteristics. These impacts would be temporary. After completion of drilling, soil could be replaced using BMPs, as discussed in Section 3.1.5, or would be disposed of off site. Removing and replacing these soils would likely result in changes to soil composition and characteristics, such as infiltration rate, within the proposed 10-acre (4-hectare) footprint.

Utility Corridors

Existing transmission line and natural gas pipeline corridors would require minimal to no construction and therefore no impacts to soils would be expected. Groundwater wells for potable and process water, would be located on or close to the proposed plant site and would require only a small distance of distribution pipeline and a negligible amount of soil disturbance.

The CO_2 pipeline corridor would be up to 59 miles (95 kilometers) long and approximately 20 to 30 feet (6 to 9 meters) wide. This would result in the disturbance and removal of up to 358 acres (145 hectares) of soil. Direct impacts from the pipeline construction would include removal of soil, soil-blowing, and compaction. Indirect impacts would include soil erosion due to runoff and wind, a decline in nearby surface water quality due to increased sedimentation, and potential groundwater contamination if a chemical spill occurred. Soil characteristics would not likely be altered by construction of the utility corridors. Soil could be replaced using BMPs to minimize impacts of removal, such as revegetation.

Transportation Corridors

The proposed site consists of existing road and railroad corridors, therefore no new corridors would need to be constructed and soils would not be directly impacted.

6.5.3.2 Operational Impacts

Direct impacts that could occur from operations include soil contamination due to leaks and spills, increased CO_2 concentration in soils due to CO_2 pipeline failures, and soil erosion due to wind. Indirect impacts include a disruption in plant growth and subsurface organisms, and groundwater contamination. It is expected that the impacts during operations would remain at a minimum due to the limited extent and current vegetative status of the proposed site. During the winter and early spring when the perched water table is within a couple of feet of the surface, the potential for groundwater contamination would be increased, but still unlikely because a spill would be immediately contained and cleaned up before contaminants could reach groundwater resource.

Power Plant Site

No additional soil disturbance is anticipated. Revegetation of disturbed areas during operations would minimize potential for erosion. During operation of the proposed plant and associated facilities, depending on amount and duration, storage of hazardous materials, as well as ash and coal piles, could cause soil contamination if in direct contact with the soil. Utilization of BMPs and construction of proper storage areas (impervious surfaces) would minimize the potential for adverse impacts.

Sequestration Site

During operations of the proposed sequestration site, the soil would not be disturbed; therefore, there would be no impacts to soil. Potential impacts due to a pipeline, surface equipment, or well failure are to be minimal, as risk abatement and safety procedures would be in place. Though it is highly unlikely, an increase of CO_2 concentration in the soil due to leaks could lower pH which could in turn cause a disruption in plant growth and occurrence of subsurface organisms (Damen et al., 2003) (e.g., microbes occurring approximately 0.9 mile [1.4 kilometers] under ground; see Section 6.9). Some levels of ground subsidence and heave have been known to be caused by petroleum production/injection operations, disposal well operations, and natural gas storage operations. Since the CO_2 injection at the Jewett Site would be at great depth and into very well consolidated rocks, the risks of any significant ground movement are small. Furthermore, since differential heave occurs most commonly when the underlying strata are tilted, faulted, or discontinuous, and the underlying strata at the proposed Jewett Site is horizontal, un-faulted, and continuous, there is a very low potential for differential settlement. Thus, the impacts of a small amount of ground heave would be negligible.

Utility Corridors

During operations the soil would not be disturbed around the utility corridors; therefore, there would be no environmental impacts associated with operations or maintenance of vegetation around the utilities during operation. Access within the utility corridors would occur through existing access roads or through access points constructed and maintained for any potential new corridors.

Transportation Corridors

During operations there would be little or no impacts to the soil due to transportation infrastructure corridor use and maintenance. Impacts could include soil-blowing, soil compaction, and soil erosion.

6.6 GROUNDWATER

6.6.1 INTRODUCTION

This section addresses groundwater resources that may be affected by the construction and operation of the proposed FutureGen Project at the proposed Jewett Power Plant Site, sequestration site, and related corridors.

6.6.1.1 Region of Influence

The ROI for groundwater resources includes aquifers that underlie the proposed power plant site, sequestration site, and aquifers that may be used to obtain water for construction and operations support. The horizontal extent varies, depending on the particular aspects of the groundwater resource, as follows:

- A distance of 1 mile (1.6 kilometers) from the proposed power plant site defines the general vicinity that could be affected by changes in groundwater quantity or quality due to the power plant footprint.
- A larger distance could be impacted by pumping to supply the water for the facility. The ROI for these wells depends on specific aquifer properties of the formations being used and well design.
- A distance of 1.7 miles (2.7 kilometers) from each sequestration injection well defines the area that could be affected by potential leaks of CO_2 from the target reservoir to overlying aquifers. This distance is based on modeling that indicates that CO_2 could migrate up to 1.7 miles (2.7 kilometers) from the site of each injection well.
- The facility footprint (including utility and transportation corridors) defines where construction or other land disturbances could take place. These areas could be susceptible to changes in groundwater infiltration, discharge, or quality. Damage to, or loss of use of, an existing well (including the potential need for well abandonment) could also occur within the facility footprint.

6.6.1.2 Method of Analysis

DOE reviewed reports from state water authorities and information in the Jewett EIV (FG Alliance, 2006c) to assess the potential impacts of the proposed FutureGen Project on groundwater resources.

Uncertainties identified in relation to groundwater resources at the Jewett Site include the porosity, brine saturation and permeability of the target formation where CO_2 would be sequestered. Analog well data was analyzed; however, site-specific test well data was not collected. Uncertainty also exists concerning the presence of transmissive faults or improperly abandoned wells in the area.

Because neither the specific aquifer to be used for the water supply nor well locations have yet been selected, the analysis addresses a number of aquifers that could be used.

DOE assessed the potential for impacts based on the following criteria:

- Depletion of groundwater supplies on a scale that would affect available capacity of a groundwater source for use by existing water rights holders, interference with groundwater recharge, or reductions in discharge rate to existing springs or seeps;
- Relationship to established water rights, allotments, or regulations protecting groundwater for future beneficial uses;

- Potential to contaminate a***n underground source of drinking water (USDW)*** through acidification of the aquifer due to migration of CO_2; toxic metal dissolution and mobilization; displacement of groundwater with brine due to CO_2 injection; and contamination of aquifers due to chemical spills, well drilling, or well completion failures; and
- Conformance with regional or local aquifer management plans or goals of governmental water authorities.

6.6.2 AFFECTED ENVIRONMENT

This section describes groundwater resources in the project area. In general, this description applies to all proposed project areas, although site-specific data is presented where available and applicable.

6.6.2.1 Groundwater Quality

Groundwater would be the source of process water for the proposed power plant at the Jewett Site and the Carrizo-Wilcox aquifer system is the only source of groundwater beneath and within the ROI of the proposed power plant site (FG Alliance, 2006c). The well field is proposed to be located in Limestone County. No sole source aquifers have been designated in the vicinity of the proposed project area (EPA, 2006a).

The Carrizo-Wilcox aquifer system consists of many hydraulically distinct and diverse units. In the proximity of the ROI, four aquifer units are formally recognized. These units are, in ascending stratigraphic order, the Hooper, Simsboro, and Calvert Bluff formations of the Eocene Wilcox Group; and the Carrizo, the lowermost formation of the Eocene Claiborne Group. The Queen City aquifer is near the proposed injection site, but is too far to the east of the injection site to be considered part of the affected environment.

The Hooper is a sequence of fluvial and deltaic sand beds separated by low permeability silt and clay lenses that act as confining units. This sequence is about 600 feet (183 meters) thick below the proposed power plant site, and contains less than 100 feet (30.5 meters) of sand.

The Simsboro is generally composed of thick, laterally extensive, medium- and coarse-grained sand beds deposited in a mixed-load fluvial system. This unit is about 200 feet (61 meters) thick near the proposed power plant site.

The Calvert Bluff extends from the surface to a depth of about 800 feet (244 meters) and is composed of inter-bedded fluvial and deltaic sand, silt, clay, and lignite beds. Similar to the Hooper unit, these sand beds act as separate aquifers. At the proposed power plant site, the Calvert Bluff formation contains less than 100 feet (30.5 meters) of sand (UTA, 1985).

The Carrizo is typically massive, white, fine- to medium-grained quartz sand with some limited amounts of thin clay lenses (TWDB, 1972). In Leon County, the Carrizo ranges in thickness from 100 to 210 feet (30.5 to 64.0 meters).

6.6.2.2 Carrizo-Wilcox Aquifer Properties

Table 6.6-1 summarizes the typical range in physical properties of each of the units in the Carrizo-Wilcox aquifer system that may serve as a potential water supply for the proposed power plant.

Table 6.6-1. Typical Range of Physical Properties of Carrizo-Wilcox Aquifer Units that May Provide Water for the Proposed FutureGen Project

Property	Hooper	Simsboro	Calvert Bluff
Well Yield, gpm (L/s)	20 - 200 (1.26 - 12.6)	500 - 1000+ (31.5 - 63.1)	20 - 200 (1.26 - 12.6)
Hydraulic Conductivity of Sands, gpd/ft^2 (cm/s)	10 - 75 (0.00047 - 0.0035)	100 - 200 (0.0047 - 0.0095)	10 - 75 (0.00047 - 0.0035)
Specific Yield (dimensionless)	0.15	0.15	0.15
Artesian Storage Coefficient (dimensionless)	0.00005	0.00005	0.00005
Transmissivity, gpd/ft (L/day/meter)	2,000 - 10,000 (24,839 – 124,193)	20,000 - 40,000 (248,387 – 496,773)	2,000 - 10,000 (24,839 – 124,193)

Note: gpm = gallons per minute; gpd = gallons per day; ft^2 = square feet; L/s = liters per second; cm/s = centimeters per second.
Source: ***FG Alliance, 2006c***.

The Carrizo-Wilcox aquifer system recharge is dependent on rainfall amounts as well as water levels in the outcrop area. These recharge rates are summarized in Table 6.6-2 and are the estimated maximum amount of water that infiltrates the surface.

Table 6.6-2. Estimated Recharge Rates for Carrizo-Wilcox Aquifer Units

Aquifer Unit	Recharge Rate, inches/year (centimeters/year)
Hooper	0.84 (2.1)
Simsboro	2.53 (6.4)
Calvert Bluff	1.01 (2.6)

Source: TWDB, 2003.

According to water quality data from wells within the ROI, groundwater from the Simsboro and Calvert Bluff aquifers is fresh, with all samples having total dissolved solids (TDS) concentrations less than 350 milligrams per liter. Table 6.6-3 shows a representative water quality analysis for the Simsboro unit. No water quality data were available for the Hooper aquifer, but it is known to produce fresh to brackish water in outcrop areas and brackish water in down dip areas. The available data shows that the groundwater in the Calvert Bluff and Simsboro aquifers meet state and federal drinking water standards for all constituents tested, and exists to depths of approximately 1,400 feet (427 meters).

Table 6.6-3. Representative Water Quality Analysis from the Simsboro Aquifer Adjacent to the Proposed Power Plant Site

Date Sampled	3/6/81
Bicarbonate (mg/L as HCO_3)	273
Calcium, Dissolved (mg/L as Ca)	2
Magnesium, Dissolved (mg/L as Mg)	2

Table 6.6-3. Representative Water Quality Analysis from the Simsboro Aquifer Adjacent to the Proposed Power Plant Site

Sodium Plus Potassium (mg/L)	113
Chloride, Dissolved (mg/L)	30
Sulfate, Dissolved (mg/L as SO_4)	17
Silica, Dissolved (mg/L as SIO_2)	11
Total Dissolved Solids (mg/L)	309
Fluoride (mg/L)	0.2

Note: mg/L = milligrams per liter; SO_4 = sulfate; SIO_2 = silica.
Source: TWDB, 2006a.

6.6.2.3 Groundwater Use

Table 6.6-4 shows the groundwater use from the Carrizo-Wilcox aquifer system in Freestone and Leon counties. Use information for each of the subdivisions of the aquifer system is not available.

Table 6.6-4. Groundwater Use in the Carrizo-Wilcox Aquifer System

Use	Limestone County	Freestone County	Leon County
	acre-feet per year (cubic meters per year)		
Municipal	1,781 (2.1x10^6)	2,511 (3.1x10^6)	1,424 (1.7x10^6)
Manufacturing	0	0	449 (553,833)
Power	852 (1.0x10^6)	99 (1.2x10^5)	0
Mining	35 (4.3x10^5)	35 (4.3x10^5)	1,067 (1.3X10^6)
Irrigation	0	0	0
Livestock	147 (1.8x10^5)	147 (1.8x10^5)	52 (6.4x10^4)
Total	**2,792 (3.4x10^6)**	**2,792 (3.4x10^6)**	**2,992 (3.7x10^6)**

Source: ***FG Alliance, 2006c***.

Limestone County does not have a groundwater management plan or any requirements for drilling permits or groundwater production permits. According to the Texas Commission on Environmental Quality (TCEQ) records, there are no cases of contaminated groundwater in the vicinity of the proposed power plant site (TCEQ, 2006).

The primary injection zone (Woodbine formation) and secondary target (Travis Peak formation) are not known to have groundwater that has commercial, industrial, or other uses.

The proposed injection wells at the Jewett Site would penetrate the units of the Carrizo-Wilcox aquifer starting with the Carrizo unit followed by the Calvert Bluff, the Simsboro, and the Hooper units.

All of these aquifers could be classified as a USDW according to EPA's definition (EPA, 2006b) of an USDW, which includes any aquifer or part of an aquifer that:

- Supplies any public water system,
- ***Contains a sufficient quantity of groundwater to supply a public water system and currently supplies drinking water for human consumption or contains fewer than 10,000 milligrams per liter of TDS; and***
- Is not an exempted aquifer.

Since the aforementioned aquifers could be classified as USDW according to EPA (440 CFR 144.3), any injection well construction must consider the protection of the resource. Section 6.6.2.2 addresses the water quality of these aquifers and Section 6.6.2.3 identifies the different uses of the resource by the local counties.

In March 2007, EPA published a Guidance (UICPG #83) determining that wells used for testing underground CO_2 sequestration technologies should be classified as Class V experimental technology wells (EPA, 2007). These wells would be subject to permitting from the State and EPA regions and this Guidance present factors that might be considered in this permitting process. These factors include the physical appropriateness of the injection sites, which include characteristics such as thickness, porosity, permeability, trapping mechanism, and confining systems. The Guidance also recommends considering the area of review based on the CO_2 plume extent and migration pathways. It also suggests that the area of review should take into account the probable pressure buildup predictions based on injection volume, depth of injection, duration of injection, and boundary conditions.

EPA also presents considerations for the construction, operation, monitoring, and closure of the wells, with the overall intent of protecting the human health and the quality of any USDW intersected or affected by the injection wells.

The State of Texas also regulates the construction, operation, monitoring, and closure of Class V wells under the Texas Administrative Code, Title 30 Part 1 Chapter 331 subchapters H and K (30 TAC 331). Under these regulations, Class V injection wells would require state permits and would be monitored as well.

6.6.3 IMPACTS

6.6.3.1 Construction Impacts

Power Plant Site

Construction activities would not be expected to disturb the groundwater resources beneath the plant or other facilities. While construction of impervious areas would hinder aquifer recharge in the immediate vicinity of the power plant site, this effect would be minimal, as the size of the aquifer recharge area is much larger than the area of impervious surface that would be created. Construction activities would not use groundwater, thus would not affect the quantity of available groundwater in the aquifer. Water for construction activities and dust control could be trucked to the site, so groundwater withdrawals would be unnecessary.

There would be no direct on-site discharge of wastewater to the subsurface. Appropriate Spill Prevention, Control, and Countermeasure (SPCC) plans would be employed to minimize the potential for spills of petroleum, oils, lubricants, and other materials used during construction and to ensure that waste materials are properly disposed of. In the event of a spill, it is unlikely that these materials would reach groundwater sources prior to cleanup. Section 6.5 provides further detail regarding soil properties, including permeability. In general, no impact on groundwater availability or quality would be anticipated due to the construction of the power plant.

Sequestration Site

The above discussion for the power plant site also applies to the sequestration sites, although considerably less impervious cover would be associated with CO_2 injection wells and equipment. The primary injection zone (Woodbine formation) is located at a depth of 1 to 1.1 miles (1.6 to 1.8 kilometers) and the secondary target (Travis Peak formation) is located 1.7 to 2.1 miles (2.7 to 3.4 kilometers). To reach these formations, the injection wells would be drilled through the Carrizo-Wilcox aquifer system and continue to the formation where CO_2 would be injected. The aquifer would be isolated by a series of conductor casings during drilling of the injection wells and thus no impacts to the shallow aquifers would be expected.

Utility and Transportation Corridors

Potential construction impacts are similar to those discussed for construction of the proposed power plant, with the exception that considerably less impervious area would be created in the corridors.

6.6.3.2 Operational Impacts

Power Plant Site

During operation of the power plant, petroleum, oils, lubricants, and other hazardous materials could be spilled onto the ground surface and potentially impact groundwater resources. However, appropriate SPCC plans would be employed to minimize the potential for such materials used during operation to be released to the surface or subsurface, and to ensure that waste materials are properly disposed of. Section 6.5 provides further detail regarding soil properties, including permeability.

The Heart of Texas region, which includes Limestone, Freestone, Hill, and Leon counties, is served by a combination of surface water and groundwater, including water from the Carrizo-Wilcox aquifer. According to planning scenarios developed by the Texas Water Development Board (TWDB), the demand for water would increase by 42 percent by year 2050 and the current combination of sources would satisfy this demand (TWDB, 1997).

A recent model developed by the state water authority (TWDB, 2006b) indicates that the regional water demand between 2010 to 2060 would increase by 38 percent (see Table 6.6-5), and the region's current water supply would be sufficient if the water management strategies are followed. These water management strategies include using a mixed supply of groundwater from different aquifers with surface water and a considerable investment in infrastructure and conservation policies. Considering that water demand for the FutureGen Project would be around 3,000 gallons (11,356 liters) per minute, or approximately 4,114 acre-feet ($5.1x10^6$ cubic meters) per year, assuming 85 percent availability, the incremental increase in water demand from the proposed project would represent less than 1 percent of the total regional demand from 2010 to 2060 (Table 6.6-5).

Table 6.6-5. Projected Water Demand[1] for 2010-2060

Category	2010 acre-feet (cubic meters)	2060 acre-feet (cubic meters)
Municipal	311,581 ($3.8x10^7$)	547,028 ($6.7x10^8$)
County-other	35,808 ($4.4x10^7$)	48,454 ($5.9x10^7$)
Manufacturing	19,787 ($2.4x10^7$)	31,942 ($3.9x10^7$)
Mining	36,664 ($4.5x10^7$)	21,243 ($2.6x10^7$)
Irrigation	232,541 ($2.9x10^8$)	208,386 ($2.6x10^8$)
Steam-electric	147,734 ($1.8x10^8$)	242,344 ($3.0x10^8$)
Livestock	51,576 ($6.3x10^7$)	51,576 ($6.3x10^7$)
FutureGen Power Plant	4,114 ($5.08x10^6$)	4,114 ($5.08x10^6$)

[1] Refers to Region ***G*** that includes Limestone County.
Source: TWDB, 2006c.

The TWDB estimated that the Carrizo-Wilcox aquifer could supply the demand for the resource well past the year 2050 without compromising the capacity to satisfy the needs of other users (TWDB, 2006b). The combined groundwater usage for Limestone, Freestone, and Leon counties is 8,576 acre-feet ($1.1x10^7$ cubic meters) per year (Table 6.6-4) and the estimated water availability from the Carrizo-Wilcox aquifer in the region is 108,531 acre-feet ($1.3x10^8$ cubic meters) in 2010 and 93,967 acre-feet ($1.2x10^8$ cubic meters) in 2060 (TWDB, 2006b). These estimates are consistent with the assertion that the quantity of water available for other users would not be in danger. Modeling by the TWDB, using the Texas groundwater availability model (GAM) for the Carrizo-Wilcox aquifer estimated water consumption of the plant (±3 percent) to assess the availability of groundwater from the Carrizo-Wilcox aquifer for this project (TWDB, 2006b). The simulations, as reported by the TWDB, indicate that the Carrizo-Wilcox aquifer in the immediate area of the proposed power plant site could supply the required facility water and all local demands, as well as additional demands past the year 2050. The modeling indicated that increased drawdown would occur in the vicinity of the pumping wells, though specific well locations have not been selected. ***Unlike other major water uses in the area (municipal and irrigation), water used in the FutureGen power plant would be discharged in the form of water vapor from the cooling towers and would not provide local recharge to the Carrizo-Wilcox aquifer (through direct or indirect discharge to groundwater). This may result in the loss of 4,000 acre-feet ($4.9x10^6$ cubic meters) per year of groundwater within the Carrizo-Wilcox aquifer***.

Sequestration Site

The potential impacts associated with CO_2 sequestration in geologic formations are largely associated with the possibility of leakage. The potential for leaks to occur would depend upon caprock integrity and the reliability of well-capping methods and, in the longer term, the degree to which the CO_2 eventually dissolves in formation waters or reacts with formation minerals to form carbonates. The mechanisms that could allow leakage of the injected CO_2 into shallower aquifers are:

- CO_2 exceeds capillary pressure and passes through the caprock;
- CO_2 leaks into the upper aquifer via a transmissive fault;
- CO_2 escapes through a fracture or more permeable zone in the caprock into a shallower aquifer;
- Injected CO_2 migrates up dip, and increases reservoir pressure and permeability of an existing fault; or
- CO_2 escapes via improperly abandoned wells or unknown wells.

CO_2 would be injected into the Woodbine formation at a depth of 1 to 1.1 miles (1.6 to 1.8 kilometers) and in the Travis Peak formation between 1.7 to 2.1 miles (2.7 to 3.4 kilometers) below the ground surface. Subsequently, it would mix with the saline groundwater in the formation. Because CO_2 is less dense than the surrounding groundwater, its buoyancy would cause it to move vertically into lower pressure zones until it reached less permeable strata which would act as a seal (e.g., caprock layer). Over time, the CO_2 would dissolve in the formation water and begin to move laterally with the groundwater flow, unless it found a more permeable conduit, such as a transmissive fault or an improperly abandoned well.

However, vertical migration of CO_2 to ***USDW*** aquifers would be highly unlikely due to:

- The depth of the injection zones in the Woodbine and Travis Peak formations;
- The substantial primary seal provided by the Eagle Ford shale (400 feet [122 meters] thick);
- The presence of at least one secondary seal (Austin Chalk); and
- A total of over 0.8 mile (1.4 kilometers) of various strata (much of it being fine grained) between the injection zone and any potable water aquifers in the project area.

Each series of less permeable and more permeable sedimentary layers within the 4,000 feet (1,219 meters) of strata would be a barrier to upward migration of CO_2. Pressure would force the CO_2 through each layer with low permeability and then dissipate due to lateral flow of CO_2 in each layer with higher permeability. There are hundreds of these series, and as a result, extensive vertical movement to ***USDW*** aquifers would not be likely.

Transmissive faults present in the subsurface ROI could also accelerate CO_2 migration. Detailed geologic mapping and investigation of the deep subsurface at the Jewett Sequestration Site has identified one fault within the subsurface ROI; however, it is interpreted as being a sealing fault (see Section 6.4). Other significant fractures have not been identified or suspected within the plume area of the sequestered CO_2. If there is a transmissive fracture in the subsurface ROI, it must penetrate and be open through over 0.8 mile (1.4 kilometers) of various types of rock to allow CO_2 migration to areas near ***USDW*** aquifers or the land surface. DOE considers it unlikely that such fractures exist in the project area because detailed geologic mapping at the site does not show evidence of deep open fractures that could allow CO_2 to migrate.

Reservoir modeling indicates that the largest plume radius would be approximately 1.7 miles (2.7 kilometers) over 20 years of injection at a rate of 2.8 million tons (2.5 MMT) per year. CO_2 movement would be expected to be primarily horizontal, with very little upward migration out of the injection zone due to trapping beneath the caprock seal provided by the Eagle Ford shale. Brine in the formation would be displaced horizontally (and vertically) for an unknown lateral distance. However, the displaced brine would have to move vertically more than 0.9 mile (1.4 kilometers) to reach the Carrizo-Wilcox aquifer. As these brines move at a rate of a few centimeters a year, it is not expected that the Carrizo-Wilcox aquifer or other source of water would be affected.

In addition to displacing brine, CO_2 would also dissolve into the brine over time. In formations like the Woodbine and Travis Peak with slowly flowing water, reservoir-scale modeling for similar projects shows that, over tens of years, up to 30 percent of the CO_2 would dissolve (IPCC, 2005). Once CO_2 dissolves in the brine groundwater, it could be transported out of the injection site by regional scale circulation or upward migration, but the time scales of such transport are millions of years and are thus not considered an impact for this assessment (IPCC, 2005).

Reactions between the CO_2 and brine would produce carbonic acid, a weak acid that would react with the formation rock. This formation is quartz-rich and reacts with minerals very slowly, taking hundreds to thousands of years (IPCC, 2005). Toxic metal displacement and dissolution could be a concern in those areas where injected CO_2 reacts with brine. However, there is a lack of mineral deposits in the area that indicate the presence of heavy metals in the surrounding formations to provide a source of leaching and subsequent transport of metals.

Acidification of the aquifer due to dissolution of CO_2 into water would slightly lower the pH of the groundwater. At the Jewett Site, acidification of shallower groundwater sources would be very unlikely due to the hundreds of feet of separation between the injection target formation and these aquifers, as well as the limited pathways for CO_2 to travel upward and mix with groundwater. Similarly, it would be unlikely that the CO_2 injection would contaminate overlying aquifers by displacing brine, because this would require pathways, such as faults or deep wells that penetrate the primary seal, that are not present at the proposed site. However, monitoring methods could help detect CO_2 leaks before they migrated into an aquifer, and mitigation measures could minimize such impacts should they occur (see Section 3.4).

Improperly abandoned wells provide one of the primary flow paths for CO_2 to reach the surface or the shallower aquifers, serving as an escape route for the pressurized gases injected into the reservoir. These flow paths are of concern when they cut through the primary seal above the reservoir. Fifty-seven such wells are known to be located within the maximum plume footprint of the two Woodbine wells. The condition of these wells is not known (FG Alliance, 2006c).

In the hypothetical case that CO_2 and brine would reach any of the USDW identified in this section, users in Limestone, Freestone and Leon counties could be impacted since they use the Carrizo-Wilcox aquifer for municipal/potable purposes.

To alleviate excess formation pressures caused by the injection of CO_2 into the Travis Peak formation, groundwater extraction wells would likely be required. Conservatively, four extraction wells would collectively pump no more than 82 million gallons (310.4 million liters) a year of saline water from the Travis Peak formation, which would either be re-injected into a shallower formation or piped off site for use in oil recovery operations (through water flooding). The formation that would receive this water is unknown and would be determined during the design phase of the project. Both disposal options are common practices in Texas and the re-injection of the water would be subject to state Underground Injection Control (UIC) regulations and permitting.

Utility Corridors

The above discussion for the power plant site also applies to the proposed utility corridors, but to a lesser extent as hazardous materials would not be expected to be on site in the utility corridors unless maintenance activities were occurring.

Transportation Corridors

Traffic accidents could result in hazardous materials spills. The spill response measures discussed for the proposed power plant site would be executed to ensure rapid control and cleanup of any hazardous material spill from a traffic accident.

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6.7 SURFACE WATER

6.7.1 INTRODUCTION

Ready access to an abundant supply of water is an important consideration in siting power plants, as water is necessary for steam generation and process water. Drinking water would also be required for the employees at the proposed power plant and sanitary wastewater would be generated by restrooms, sinks, and shower facilities. The proposed FutureGen Power Plant would not discharge any industrial wastewater; all process wastewater would be treated by the zero liquid discharge (ZLD) system and recycled back to the power plant. The following analysis evaluated short-term impacts from construction and long-term impacts from operations to surface water resources from the proposed FutureGen Project.

6.7.1.1 Region of Influence

The ROI consists of the proposed power plant site, sequestration site, areas within 1 mile (1.6 kilometers) of all related areas of new construction, and any surface water body above the sequestration reservoir.

The greatest potential for impacts to surface water resources is limited in most cases to the proposed power plant and sequestration site and related corridors. Because of the types of land disturbing activities that would occur during construction of the proposed power plant, injection wells, and supporting utilities and infrastructure, the disturbed areas would be susceptible to erosion and changes in surface water flow patterns. The area could also be affected by spills associated with construction or operations.

In some cases, the ROI for surface water extends beyond the proposed construction sites. Construction and operation activities would affect a larger area in cases where flow patterns were modified or if contamination could be carried downstream by surface water drainages.

6.7.1.2 Method of Analysis

DOE reviewed public data, research, and studies compiled in the Jewett EIV (FG Alliance, 2006c) to characterize the affected environment.

DOE assessed the potential for impacts based on whether the proposed FutureGen Project would:

- Alter stormwater discharges, which could affect drainage patterns, flooding, and erosion and sedimentation;
- Alter infiltration rates, which could affect (substantially increase or decrease) the volume of surface water that flows downstream;
- Conflict with applicable stormwater management plans or ordinances;
- Contaminate public water supplies and other surface waters exceeding water quality criteria or standards established in accordance with the Clean Water Act (CWA), state regulations, or permits;
- Conflict with regional water quality management plans or goals;
- Affect capacity of available surface water resources;
- Conflict with established water rights or regulations protecting surface water resources for future beneficial uses;
- Alter floodway or floodplain or otherwise impede or redirect flows such that human health, the environment or personal property is impacted; or
- Conflict with applicable flood management plans or ordinances.

DOE reviewed reports from USGS, EPA and TCEQ, and reviewed information provided in the Jewett EIV (FG Alliance, 2006c) to assess the potential impacts of the proposed FutureGen Project on surface water resources. Surface water data analysis was limited to locations that had the potential for permanent impacts (i.e., power plant and sequestration site); however, site-specific surface water data for these areas were not collected. Data were evaluated from area discharge points and sample locations monitored by the agencies previously mentioned. Best professional judgment was applied to determine the likelihood of surface water impairments in the area. Uncertainties and unavailable data are discussed as appropriate in the following analysis.

To avoid or limit adverse impacts, emphasis is placed on adhering to applicable laws, regulations, policies, standards, directives, and BMPs. Most importantly, careful pre-planning of construction and operational activities would allow potential impacts to be minimized before they occur.

6.7.2 AFFECTED ENVIRONMENT

Power Plant Site

The proposed Jewett Power Plant Site consists of 400 acres (162 hectares) located approximately 6 miles (9.7 kilometers) from the Town of Jewett, Texas (FG Alliance, 2006c). Figure 6.7-1 shows the proposed power plant site, sequestration site, proposed utility corridors and surface water resources in the area. The nearest significant waterbody is Lake Limestone approximately 3 miles (4.8 kilometers) west of the proposed power plant site.

The proposed power plant site is located in the Texas-Gulf Region of the Trinity River Basin (TCEQ, 2006a). Figure 6.7-1 shows the surface water resources and topography of the site surrounding the proposed location. Lynn, Red Hollow, and Lambs Creeks, along with the Cottonwood Springs Branch are all intermittent (seasonal flow) creeks within the ROI of the power plant site. Red Hollow Creek follows along the southeast border of the proposed site and cuts across the northeast section of the proposed site. Lynn Creek parallels the northwest border of the site, but is between 0.08 and 0.38 mile (0.13 and 0.61 kilometer) away. Both creeks drain into Lambs Creek, which has an unnamed tributary that runs from the center of the proposed site; Lambs Creek eventually drains into Lake Limestone. The Cottonwood Springs Branch flows near the confluence of Red Hollow and Lambs Creek south until its termination approximately 2 miles (3.2 kilometers) south of the proposed site.

Sequestration Site

The land above the proposed sequestration site is approximately 33 miles (53 kilometers) northeast of the proposed plant site and is located in the Trinity River Basin and straddles the Trinity River (FG Alliance, 2006c). The following surface water bodies are located within the sequestration site ROI: Willow Creek, Edwards Creek, Rocky Branch, Indian Creek, Catfish Creek, Spring Creek, Lake Creek, Keechie Creek, Upper Keechi Creek, Town Creek, Gaston Branch, Saline Branch, Cedar Lake Slough, and Trinity River.

Utility Corridors

Review of USGS maps of the proposed water supply pipeline corridor revealed that several surface water bodies exist within the corridor. However, field investigations were not completed to confirm the presence or absence of flowing or intermittent areas.

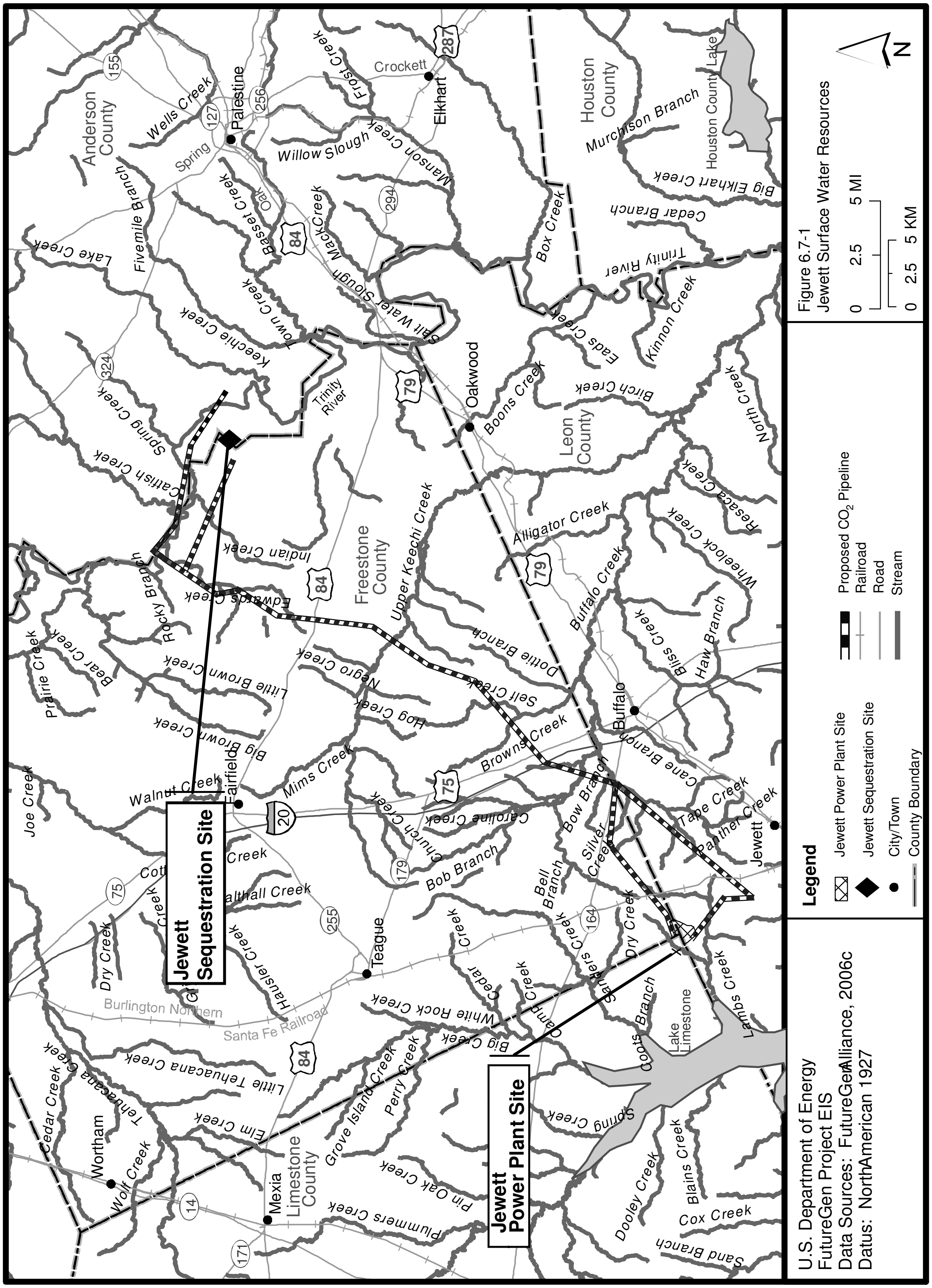

Figure 6.7-1
Jewett Surface Water Resources

Review of USGS maps for the proposed CO_2 pipeline corridor revealed that approximately 30 water resources occur within the corridor: Red Hollow Creek, Lynn Creek, Lambs Creek, Spring Branch, Needham Marsh, Nanny Branch, Thundering Springs, Silver Creek, Rena Branch, Bow Branch, Buffalo Creek, Whitney Branch, Fulks Dugout, Chandler Bottom, Browns Creek, Self Creek, Plum Creek, Upper Keechi Creek, Alligator Creek, Holly Branch, Brinkley Creek, Batsmith Creek, Edwards Creek, Willow Creek, Cold Springs Branch, Indian Creek, Alum Branch, Evans Lake, Cedar Lake Slough, Lake Creek and the Trinity River.

Transportation Corridors

Because no new transportation corridors are proposed outside of the power plant site, this section does not include a description of the affected surface waters. Any potential upgrades to existing transportation corridors are anticipated to occur in existing maintained ROWs.

6.7.2.1 Surface Water Quality

The tributaries within the ROI of the proposed plant site are unclassified by the State of Texas and therefore no designated uses for them have been established (TCEQ, 2006a). Because there are no designated uses and no existing known contamination of these creeks, no water quality assessments have been made to determine if the creeks are impaired for any uses (FG Alliance, 2006c).

Lake Limestone is approximately 3 miles (4.8 kilometers) west of the proposed plant site and was assessed during the 2002 Texas Water Quality Survey for the period of 1996-2001. The aquatic life, contact recreation, public water supply, and general uses are fully supported and no impairment is listed; however, the fish consumption use of the lake was not assessed. Two concerns listed for Lake Limestone in 2002 were related to nutrient enrichment for nitrogen near the north-central portion of the lake above the confluence of Lambs Creek and also at the south end near the dam (TCEQ, 2004).

The Trinity River, above Lake Livingston, has designated uses (as established by TCEQ) for aquatic life, general contact recreation, and fish consumption. A segment of the Trinity River near the sequestration site was classified as a concern for nutrient enrichment and algal growth, due to high nitrogen and phosphorous levels during the 2002 Texas Water Quality Survey (TCEQ, 2004). No water quality standard is currently being exceeded and no regulatory action is required at this time (FG Alliance, 2006c). This segment was delisted from the State of Texas' 303(d) list for bacterial impairment (TCEQ, 2004). Water quality data for the remaining surface water bodies in the area of the sequestration site are not available.

The nearest water quality monitoring station to the proposed sequestration site is Trinity River Station ID#10919, located at U.S. Highway 79 Northeast of Oakwood, Texas. Recent water quality data were available through the Trinity River Authority and is shown in Table 6.7-1 (TRA, 2006). This station is located west of the proposed sequestration site and the reported monitoring data indicate that the quality of the Trinity River at the sampling point has been fairly consistent over the past 5 years.

6.7.2.2 Process Water Supply and Quality

No surface water would be used for the process water supply for the proposed power plant site. Process water would be provided by on-site or possibly off-site groundwater wells, as discussed in Section 6.6.

Table 6.7-1. Annual Average Water Quality Data for the Trinity River Station

Parameter	Unit	Year						Texas Surface Water Quality Stds
		2000	2001	2002	2003	2004	2005	
Temperature	°C	20.99	20.96	21.23	20.98	20.53	21.63	33.9
Conductance	µs/cm	582.83	539.78	507.47	619.92	480.00	642.50	NS
Dissolved Oxygen	mg/L	9.61	7.75	7.99	8.61	7.71	8.51	5.0
pH		7.85	7.67	7.84	7.97	7.89	8.03	6.5-9.0
Ammonia	mg/L	0.06	0.06	0.10	0.11	0.04	0.02	NS
Total Kjeldahl Nitrogen	mg/L	1.21	0.77	0.92	1.36	1.14	0.95	NS
Nitrites plus Nitrates	mg/L	7.10	5.54	4.88	5.28	3.02	7.35	NS
Total Phosphorous	mg/L	0.87	0.91	0.77	1.16	0.69	1.05	NS
Total Hardness	mg/L	171.00	168.50	175.17	187.92	171.67	173.83	NS
Sulfates	mg/L	70.00	64.00	61.67	82.80	N/A	N/A	NS
E. Coli	MPN/100mL	129.80	243.21	476.08	248.18	99.45	N/A	NS
Chlorophyll a	µg/L	12.39	15.23	11.04	20.79	11.42	19.78	NS

°C = degrees Celsius; µs/cm = microSiemens per centimeter; mg/L = milligrams per liter; MPN/100mL = most probable number; µg/L = micrograms per liter; NS = No Standard.
Source: TRA, 2006; TNRCC, 2000.

6.7.3 IMPACTS

6.7.3.1 Construction Impacts

Water would be required during construction for dust suppression and equipment washdown and would most likely be trucked to areas where needed; no water would be withdrawn from surface waters. BMPs would be used to contain water used for dust suppression and equipment washdown, and would have little to no impact to surface water quality. This activity would be addressed in a NPDES Permit (discussed below). Proposed grades in paved areas and for building first floor elevations would be as close to existing grade as feasible to minimize side slopes. All temporarily disturbed areas would be seeded to re-establish vegetative cover.

Because there would be over 1 acre (0.4 hectare) of disturbance, the construction contractor would need to apply for a general NPDES Permit No. TXR150000 from the TCEQ, which requires the preparation of a Storm Water Pollution Prevention Plan (SWPPP). Part III of the general NPDES permit includes erosion control and pollution prevention requirements and refers to specific construction standards, material specifications, planning principles and procedures. The plans are required to include site specific BMPs. Operating stormwater pollution prevention restrictions and BMPs will be dictated by the NPDES permit.

A **Storm Water Pollution Prevention Plan** consists of a series of phases and activities to characterize the site and then select and carry out actions to prevent pollution of surface water drainages.

Impacts due to construction activities would likely include erosion due to equipment moving, surfacing and leveling activities, and alteration of surface structures resulting in effects on local (i.e., at the point of disturbance) hydrology. In addition, Clean Water Act Section 404 permits (hereafter referred to as Section 404) are required for jurisdictional waterbody (wetland) crossings and will be issued before construction. Section 404 permits require the use of BMPs during and after construction and oftentimes include mitigation measures for unavoidable impacts.

Power Plant Site

There are currently no major surface water reservoirs, lakes, or ponds within the 1-mile ROI (FG Alliance, 2006c). The closest significant waterbody is Lake Limestone, which is located approximately 3 miles (4.8 kilometers) west of the site (FG Alliance, 2006c). There are intermittent streams with small associated wetlands, as described in Section 6.8. During construction, increases in impervious surfaces would decrease the available surface area to allow infiltration from precipitation and subsequently increase the amount of stormwater runoff. Presently, area soils are moderately to well drained, so the likelihood that construction activities will significantly alter stormwater runoff patterns is low (***FG Alliance, 2006c and*** USDA, 1998, 2002). It is expected that any potential impact to surface water quality from stormwater runoff would be mitigated by BMPs defined in the SWPPP required by the NPDES General Permit.

Sequestration Site

The sequestration site is minimally developed wooded and savannah habitat (FG Alliance, 2006c). The proposed sequestration site is northeast of the proposed power plant site and is located in the Trinity River Basin, straddling the Trinity River as shown in Figure 6.7-1. This area is characterized by numerous intermittent and perennial creeks, small ponds, and reservoirs (FG Alliance, 2006c).

The construction of injection wells would disturb minor amounts of land which could cause temporary indirect impacts to adjacent surface waters such as sedimentation and surface water turbidity from runoff. These impacts would be minimized or avoided through the use of BMPs.

Increases in impervious surfaces would decrease the available surface area to allow infiltration from precipitation and subsequently increase the amount of stormwater runoff. Presently, area soils are moderately to well drained, so the likelihood that construction activities would significantly alter stormwater runoff patterns is low (***FG Alliance, 2006c and*** USDA, 1998, 2002). It is expected that any potential impact to surface water quality from stormwater runoff will be mitigated by BMPs defined in the SWPPP required by the NPDES General Permit for Construction Activities.

Utility Corridors

Construction activities associated with the construction of the process water pipeline and other underground utility lines are not anticipated to cross or impact surface water resources, except for the proposed CO_2 pipeline, described below. The construction of new pipelines for utility corridors would require hydrostatic testing of the lines to certify the material integrity of the pipeline before use. These tests consist of pressurizing the pipeline with water and checking for pressure losses due to pipeline leakage. Hydrostatic testing would be performed in accordance with U.S. Department of Transportation (DOT) pipeline safety regulations. The source and quantity of water for hydrostatic testing is further discussed in Section 6.6.

Water used for hydrostatic testing is required to be contained in approved fluid holding or disposal facilities. Hydrostatic pipe and well testing waters may not be discharged to the surface (TCEQ, 2006b).

No chemical additives would be introduced to the water used to hydrostatically test the new pipeline, and no chemicals would be used to dry the pipeline after the hydrostatic testing. Hydrostatic testing would be conducted in accordance with applicable permits.

The related areas of new construction associated with the proposed power plant include a proposed water supply pipeline corridor and six segments of proposed CO_2 pipeline corridor. A new CO_2 pipeline would be required to connect the proposed power plant site to the proposed sequestration site. The pipeline would be up to 59 miles (95 kilometers) in length and the ROW would be approximately 20 to 30 feet (6 to 9 meters) wide. The proposed CO_2 pipeline has been divided into the following common segments, except for segments A-C and B-C which are alternatives between the proposed plant site and the beginning of segment C:

- Segment A-C would begin on the western side of the proposed plant site and follow 2 miles (3.2 kilometers) of existing ROW owned by the Burlington Northern – Santa Fe Railroad. It would continue approximately 3 miles (4.8 kilometers) along new ROW until it intersects a section of natural gas pipeline ROW. The corridor would then follow this pipeline another 3 miles (4.8 kilometers) east until it joins a larger trunk of natural gas pipeline.
- Segment B-C would begin along the southern boundary of the proposed plant site and extend east approximately 2.5 miles (4.0 kilometers) along FM 39. It then would turn north and follow the existing ROW of a natural gas pipeline for another 4 miles (6.4 kilometers) until it joins a ROW for a larger trunk of natural gas pipeline that extends northward for approximately 8 miles (12.9 kilometers).
- Segment C-D would follow an existing natural gas line ROW northward for approximately 15 miles (24.1 kilometers).
- Segment D-F would continue northward along the existing natural gas line ROW for another 9 miles (14.5 kilometers).
- Segment F-G would extend in a straight line east along new ROW approximately 6 miles (9.7 kilometers) to the proposed sequestration wells on the Hill Ranch.
- Segment F-H would continue northward along the existing natural gas line corridor for almost 2 miles (3.2 kilometers) where it would cross Trinity River to the north side. It then would intersect another leg of natural gas pipeline ROW and continue east for approximately 6 miles (10 kilometers). The line would then turn and continue along county highway ROW and TDCJ land for approximately another 6 miles (9.7 kilometers) to the proposed injection well site on TDCJ land.

The utility lines would follow existing utility corridors; therefore, it is not expected that utility corridor construction would be required. Review of USGS maps of the proposed water supply pipeline corridor revealed that several surface water bodies exist within the corridor. However, field investigations were not completed to confirm the presence or absence of flowing or intermittent areas.

Review of USGS maps for the proposed CO_2 pipeline corridor revealed that several areas potentially subject to Section 404 jurisdiction exist within the corridor. Portions of all six segments of the proposed CO_2 pipeline corridor cross approximately 30 stream channels, including Red Hollow Creek, Lynn Creek, Lambs Creek, Spring Branch, Needham Marsh, Nanny Branch, Thundering Springs, Silver Creek, Rena Branch, Bow Branch, Buffalo Creek, Whitney Branch, Fulks Dugout, Chandler Bottom, Browns Creek, Self Creek, Plum Creek, Upper Keechi Creek, Alligator Creek, Holly Branch, Brinkley Creek, Batsmith Creek, Edwards Creek, Willow Creek, Cold Springs Branch, Indian Creek, Alum Branch, Evans Lake, Cedar Lake Slough, Lake Creek and the Trinity River. Site assessments would be necessary to determine the appropriate methods for stream crossing. Directional drilling could be used to avoid impacts to these surface water resources. Section 404 permits would be required for all stream crossings.

Transportation Corridors

No new transportation corridors are proposed; only upgrades to existing roads and new transportation spurs within the proposed power plant footprint. As such, the potential impacts from project construction are discussed under the proposed power plant site. Any unforeseen major upgrades or new transportation corridors would require a separate analysis.

6.7.3.2 Operational Impacts

Potential operational impacts would consist largely of surface water runoff from the proposed power plant site and potential spills (i.e., fuel, chemicals, grease, etc.). Mitigation of runoff, recycling of materials, and pollution prevention measures would reduce or eliminate the potential for operational impacts to surface water. A pollution prevention program would be implemented to reduce the incidence of site spills (i.e., fuel, paint, chemicals, etc.). Adherence to applicable laws, regulations, policies, standards, directives and BMPs would avoid or limit potential adverse operational impacts to surface waters.

Stormwater runoff from the proposed plant site would be expected to have minimal impact on surface water resources. Stormwater could be collected and recycled into the process water to support the operations of the proposed power plant. Possible sedimentation due to soil and wind erosion could occur, but impacts to surface waters are considered to be negligible.

Power Plant Site

No impacts to surface water from water usage by the proposed facility would be expected because groundwater would be the primary source of the process and potable water supply. Potentially, the site could discharge sanitary sewer waste to the surface, reinject the water to groundwater, or recycle it back into the process water to support the operations of the proposed power plant. The method of on-site waste systems has not been determined (see discussion in Section 6.15). Appropriate permits would be secured before any discharges. Discharge frequency, quantity, and quality would be subject to permit requirements.

During operations, slag and coal piles would be stored on site. Although, the actual configuration has yet to be determined, for the purposes of this analysis, it is presumed that these storage areas would be stored in open air, lined areas. Implementation of BMPs and a stormwater management system would capture the runoff from the coal piles, and direct it to the zero liquid discharge system for on-site treatment. Further mitigation could include covering the slag and coal pile areas to prevent contact with precipitation and eliminate stormwater runoff. Minimal effects to downstream surface water resources would be anticipated because the proposed power plant would be a zero emissions facility.

Increases in impervious surfaces would decrease the available surface area to allow infiltration from precipitation. Runoff from the site due to industrial activities would require implementing a stormwater management program to reduce or eliminate any potential surface water quality impacts. The general NPDES Permit would include erosion control and pollution prevention requirements. Operating stormwater pollution prevention restrictions and BMPs would be dictated by the NPDES permit.

Sequestration Site

The operation of the proposed sequestration site is not expected to impact surface water resources within the ROI. In the event a CO_2 leak, an increased concentration of CO could occur within these surface waters. In surface waters lacking buffering capacity, such as freshwater and stably stratified waterbodies, the pH could be significantly altered by increases in CO_2 (Benson et al., 2002). The persistence and amount of CO_2 being leaked are primary factors which determine the severity of the impacts from increased CO_2 in the soil and surface water (Damen et al., 2003). The risk of a CO_2 leak from the sequestration reservoir is dependent upon the reservoir and other site specific variables, such as the integrity of the well and cap rock and the CO_2 trapping mechanism (Reichle et al., 1999). CO_2 sequestration is maintained via a sealed caprock, which can be compromised via, rapid release of CO_2 through natural events or unplugged wells, or slow leaks of CO_2 through rock fractures and fissures. These are influenced by the characteristics (e.g., porosity) of the caprock material. As discussed in Section 6.4, the potential for CO_2 leakage from the proposed Jewett Sequestration Reservoir is small, but it could occur. The sequestration reservoir would occur far below these surface water resources and any connected aquifers, preventing any point of contact. The intermittent and ephemeral nature of streams within the ROI would further reduce this risk to surface waters. A risk analysis was completed to assess the likelihood of such failures occurring, as discussed in Section 6.17 (Tetra Tech, 2007).

A CO_2 monitoring program would be implemented to detect a leak, should one occur. Seepage of sequestered gases from the reservoir would not impact surface water because the solubility of CO_2 in water would keep the concentration less than 0.2 percent (Tetra Tech, 2007). The monitoring for CO_2 leaks in the pipeline and caprock would enable the application of BMPs should a leak be detected.

Utility Corridors

Normal operations of the power transmission corridors and pipelines for the proposed site would not affect surface water resources. Occasional maintenance may require access to buried portions of the utilities; however, BMPs would be used to avoid any indirect impacts (e.g. sedimentation and turbidity) to adjacent surface waters.

Leakage from the proposed pipeline that would transport the CO_2 to the injection site could increase concentration of CO_2 in the soil, which would lower the pH and negatively affect the mineral resources in the affected soil, which in turn would lower the pH of the surface waters in the affected area, potentially resulting in calcium dissolution and alteration of the concentration of trace elements in the surface water (Damen et al. 2003; Benson et al., 2002). The pipeline is expected to be buried to a depth of about 3.3 feet (1.0 meter), therefore, if a leak or rupture occurred, the released gas would first migrate into the soil gas and displace the ambient air, before being discharged into the surface water. A monitoring program would be implemented to monitor CO_2 to detect a leak, should one occur.

Transportation Corridors

Operation of the power plant would use existing transportation corridors, and therefore, would have no impact on surface water resources. Any upgrades to existing corridors would require a separate analysis.

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6.8 WETLANDS AND FLOODPLAINS

6.8.1 INTRODUCTION

This section discusses wetlands and floodplains identified in the affected environment that may be affected by the construction and operation of the proposed FutureGen Project at the Jewett Power Plant Site, sequestration site, and related corridors. This section also provides the required floodplain and wetland assessment for compliance with 10 CFR Part 1022, "Compliance with Floodplain and Wetland Environmental Review Requirements," and Executive Orders 11988, "Floodplain Management," and 11990, "Protection of Wetlands (May 24, 1977)."

6.8.1.1 Region of Influence

The ROI for wetlands and floodplains for the proposed Jewett Power Plant includes the proposed power plant site and the area within 1 mile (1.6 kilometers) of the boundaries of the proposed power plant site, sequestration site, and utility and transportation corridors.

6.8.1.2 Method of Analysis

DOE reviewed research and studies in the Jewett EIV (FG Alliance, 2006c) to characterize the affected environment. DOE also conducted site visits in August and November 2006, which provided additional information related to the affected environment.

DOE assessed the potential for impacts based on whether the proposed FutureGen Project would:

- Cause construction of facilities in, or otherwise impede or redirect flood flows in, a 100- or 500-year floodplain or other flood hazard areas;
- Conflict with applicable flood management plans or ordinances; and
- Cause filling of wetlands or otherwise alter drainage patterns that would affect wetlands.

6.8.2 AFFECTED ENVIRONMENT

6.8.2.1 Wetlands

Executive Order 11990 requires federal agencies to avoid short and long-term impacts to wetlands if no practicable alternative exists. In addition, all tributaries to Waters of the U.S., as well as wetlands contiguous to and adjacent to those tributaries, are subject to federal jurisdiction and potential permitting requirements under Section 404. These resources are ***federally*** jurisdictional, or regulated by ***the United States Army Corps of Engineers (USACE)***. To be contiguous or a tributary, a continuous surface water connection must be present between the Waters of the U.S. and the adjacent surface water body. This surface water connection can be either visible surface water flowing at regular intervals of time, or a continuum of wetlands between the two areas. Open water features (e.g., upland stock ponds) within the Federal Emergency Management Agency (FEMA) designated 100-year floodplain that have associated emergent vegetation fringe are also jurisdictional Waters of the U.S. Isolated wetlands ***(those that have no apparent connection to Section 404 resources)*** are not jurisdictional unless protected under a bylaw ***discussed below***.

The localUSACE Regulatory Branch makes jurisdictional determinations. Activities such as mechanized land clearing, grading, leveling, ditching, and redistribution of material require a permit from the USACE to discharge dredged or fill material into wetlands. Permit applicants must demonstrate that they have avoided wetlands, and have minimized the adverse effects of the project to the extent practicable. Compensation is generally required to mitigate most impacts that are not avoided or minimized.

Horizon Environmental Services identified jurisdictional wetlands in the proposed power plant site in 2006. National Wetland Inventory (NWI) mapping provided information on wetlands within the proposed sequestration site and utility corridors. Figure 6.8-1 shows the general location of mapped wetlands identified using the Cowardin et al. classification scheme (Cowardin et al., 1979).

Power Plant Site

Portions of ***wetlands, ponds, and channels*** within the proposed power plant site have been previously disturbed as part of the Jewett Surface Lignite Mine operation. Most of Red Hollow Channel along the eastern boundary of the proposed site has been modified for mine drainage, with the inclusion of two large constructed impoundments (ponds) for sedimentation control. Due to previous disturbance, this jurisdictional feature was low quality (FG Alliance, 2006c). The modifications were made in accordance with a USACE Section 404 permit issued to the Jewett Surface Lignite Mine.

A portion of an original branch of the Red Hollow Channel extends to a small, on-channel (jurisdictional) pond near the northern part of the proposed power plant site. This feature still exists in its natural state and is jurisdictional. Due to its undisturbed condition and ephemeral nature, this stream has moderate ecological value. A small, unnamed tributary is also in the central portion of the southern half of the site. This tributary extends toward another constructed mine sediment pond and has low ecological value due to previous disturbances. The jurisdictional nature of this sediment pond is dependent upon the final disposition of the pond following mining activity. Two small wetland areas are located in a pasture in the western part of the southern half of the proposed Jewett Power Plant Site. These wetlands are isolated and non-jurisdictional.

The total jurisdictional area is estimated to be 2 acres (0.8 hectare) of low-quality palustrine wetland, 0.14 acre (0.04 hectare) of medium-quality palustrine wetland, and 18 acres (7.3 hectares) of low-quality ponds of questionable jurisdictional status (FG Alliance, 2006c).

Further review of NWI maps indicated numerous ***wetlands, ponds, and channels*** within the 1-mile (1.6-kilometer) ROI of the proposed Jewett Power Plant Site. The majority of the features are categorized as upland man-made stock pond. These areas are generally of low quality due to the previous mining activities and are typically non-jurisdictional by USACE. However, both Lambs Creek and Lynn Creek are located within the ROI and would be jurisdictional by USACE, even though they have been modified due to mining activities. Five palustrine forested wetlands are identified with Lynn Creek. One palustrine emergent, seasonally flooded wetland feature is associated with Lambs Creek.

Sequestration Site

NWI mapping indicates over 43 areas potentially subject to Section 404 jurisdiction on the proposed sequestration site. Major watershed features within this area include the Trinity River, Spring Lake, Cedar Lake Slough, Big Lake, Evans Lake, Indian Creek Lake, Little Red Lake, Red Lake, Blue Lake, Harding Lake, Jelly Slough, and Upper Keechi Creek (***FG Alliance, 2006c***). Small herbaceous and forested wetlands associated with the creeks and tributaries, as well as on-channel stock ponds were identified, but a jurisdictional determination has not been performed. Field verification (wetland delineation) would be required to confirm the NWI mapping and determine the acreages and value of these resources***, including any isolated wetlands***.

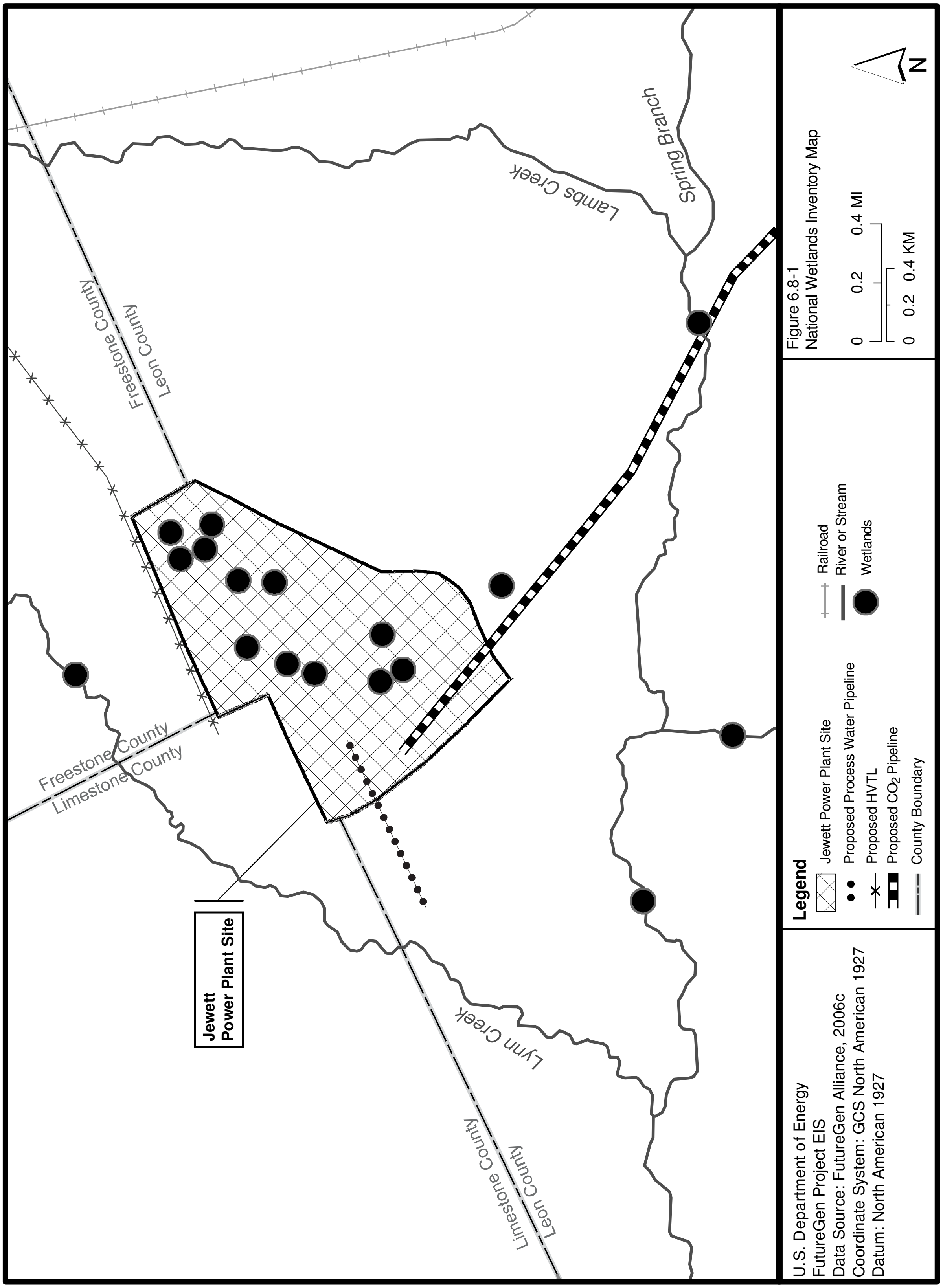


Figure 6.8-1
National Wetlands Inventory Map

Utility Corridors

The related areas of new construction associated with the proposed power plant include a proposed water supply pipeline corridor and six segments of proposed CO_2 pipeline corridor. A review of NWI maps of the proposed water supply pipeline corridor revealed that no potential wetlands or Waters of the U.S. exist within the corridor. However, field investigations were not completed and confirmation of the presence or absence of areas that are subject to Section 404 jurisdiction would be required for permit approval.

Review of NWI maps for the proposed CO_2 pipeline corridor revealed that over 90 areas potentially subject to Section 404 jurisdiction exist within the corridor. Portions of all six segments of the proposed CO_2 pipeline corridor cross approximately 30 stream channels including Red Hollow Creek, Lynn Creek, Lambs Creek, Spring Branch, Needham Marsh, Nanny Branch, Thundering Springs, Silver Creek, Rena Branch, Bow Branch, Buffalo Creek, Whitney Branch, Fulks Dugout, Chandler Bottom, Browns Creek, Self Creek, Plum Creek, Upper Keechi Creek, Alligator Creek, Holly Branch, Brinkley Creek, Batsmith Creek, Edwards Creek, Willow Creek, Cold Springs Branch, Indian Creek, Alum Branch, Evans Lake, Cedar Lake Slough, Lake Creek and the Trinity River. Quality of these waterbody crossings varies throughout the region. The segments also traverse forested, scrub-shrub, and emergent wetlands associated with these waterways and on-channel impoundments. Specifically, segment A-C crosses 6 wetlands; B-C crosses 19 wetlands; C-D crosses 20 wetlands; D-F crosses 12 wetlands; F-G crosses 18 wetlands; and F-H crosses over 11 wetlands. Field verification would be required to confirm the NWI mapping and determine the acreages and value of these resources***, including any isolated wetlands.***

Transportation Corridors

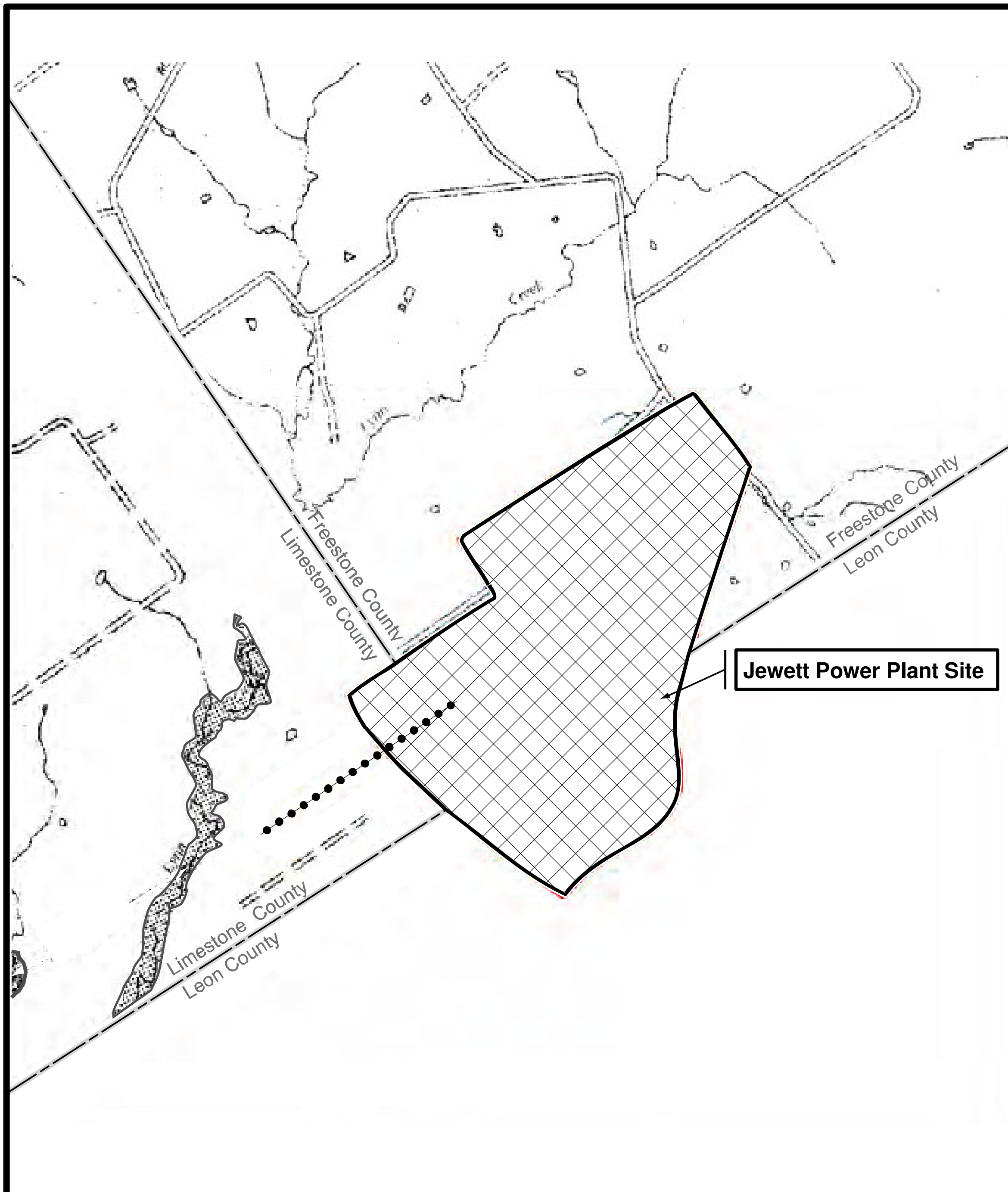
Because no new transportation corridors are proposed outside of the proposed power plant site, this EIS does not provide further description of wetlands. Any upgrades to existing transportation corridors are anticipated to occur in existing maintained ROWs.

6.8.2.2 Floodplains

Power Plant Site

FEMA flood insurance rate maps indicate that the proposed Jewett Power Plant Site within Limestone and Freestone counties is located outside of the 100- and 500-year floodplain boundaries (***FG Alliance, 2006c***) (Figure 6.8-2).

The portion of the proposed power plant site that lies within Leon County has not been mapped for flood hazard areas. The Natural Resources Conservation Service (NRCS) Web Soil Survey indicates that soils on the proposed power plant site, including portions of Limestone, Freestone, and Leon counties, have a flooding frequency class of "none," which means a zero percent chance of flooding in any given year, or less than one time in 500 years (NRCS, 2006). In a letter dated May 22, 2006, the Limestone County Engineer and Floodplain Administrator stated that, based upon the soil survey information for Leon County, the portion of the proposed Jewett Power Plant Site located within Leon County also lies outside of the 100-year floodplain (Kantor, 2006) (see Appendix A).



U.S. Department of Energy
FutureGen Project EIS
Data Source: FutureGen Alliance, 2006c

Legend

- Jewett Power Plant Site
- Proposed Process Water Pipeline
- 100-Year Flood Zone (Zone A) No base flood elevations
- Paved Road/Highway
- Unpaved Road

FEMA floodplain data is not available for Leon County

Figure 6.8-2
Jewett Floodplain Map

0 1,000 2,000 ft
0 200 m

N

Sequestration Site

Approximately 25 percent of the proposed sequestration reservoir is located within the 100-year floodplain. The Trinity River, several creeks, sloughs, and a few small ponds and reservoirs make up this portion of the floodplain.

Utility Corridors

The related areas of new construction associated with the proposed power plant include a proposed water supply pipeline corridor and seven segments of proposed CO_2 pipeline corridor. The entire proposed water supply pipeline corridor is located outside of the 100- and 500-year floodplains.

Portions of all six segments of the proposed CO_2 pipeline corridor are located within a 100-year floodplain boundary. None are located within the 500-year floodplain. Locations within the 100-year floodplain include Bow Branch in the easternmost portion of Segment A-C; Rena Branch, Alligator Creek, and Bow Branch in the easternmost portion of Segment B-C; Buffalo Creek, Whitney Creek, Browns Creek, Self Creek, and Keechi Creek in Segment C-D; and Brinkley Creek, Batsmith Creek, Willow Creek, and Edwards Creek in Segment D-F. More than half of Segment F-G and almost all of Segment F-H are located within the 100-year floodplain.

The soil survey for the Leon County portion of Segment B-C that crosses Lambs Creek, Needham Marsh, Thundering Springs Branch, Silver Creek, and Rena Branch shows a flooding frequency class of “frequent,” which means flooding is likely to occur (NRCS, 2006). The remaining soils within this portion of Segment B-C have a flooding frequency class of “none.”

Transportation Corridors

Because no new transportation corridors are proposed outside of the proposed power plant site, this EIS does not include further description of floodplains. Any upgrades to existing transportation corridors are anticipated to occur in existing maintained ROWs.

6.8.3 IMPACTS

6.8.3.1 Construction Impacts

Direct impacts to wetland habitats would be related to heavy equipment and construction activities, and could include soil disturbance and compaction, dust, vegetation disturbance and removal, root damage, erosion, and introduction and spread of non-native species. The addition of silt, resuspension of sediment, or introduction of pollutants (e.g., fuels and lubricants) related to, and in the immediate vicinity of, construction activities could degrade the quality of native wetlands.

The proposed FutureGen Project could result in localized, direct, and adverse construction impacts to wetlands. Filling or modifying portions of wetlands, if avoidance is not feasible, would permanently alter hydrologic function and wetland vegetation, and result in direct habitat loss. Potential habitat degradation of wetlands and waters downstream could also occur if flow into adjacent areas is reduced. Construction impacts would be mitigated by minimizing the areas disturbed and preventing runoff from entering wetlands during construction. Section 404 jurisdiction would be required for permit approval.

The amount of mitigation required for the proposed power plant site and other project components (e.g., utility corridors) is not known at this time. Ratios have been established by the USACE regarding mitigation. For example, a 1:2 ratio would require 2 acres (0.8 hectare) of wetland creation for every acre

(0.4 hectare) of wetland loss. Typical mitigation ratios for unavoidable impacts to wetlands would be 1:1 for open water and emergent wetlands, 1:5 for shrub wetlands, and up to 2:1 for forested wetlands. The appropriate type and ratio of mitigation would be determined through the Section 404 permitting process. ***Tables 3-13 and 3-14 in Section 3.4 provide potential mitigation measures and best management practices to avoid, minimize, and offset impacts to wetlands.***

Power Plant Site

The proposed Jewett Power Plant Site contains three tributary streams potentially subject to Section 404 jurisdiction, two of which were previously modified and are of low value. The third tributary has not been previously modified, but is ephemeral in nature and is of moderate value. Three recently constructed sedimentation ponds related to the mine have questionable jurisdictional status; however, if they are later determined to be jurisdictional, they would likely be of low value. The total number of jurisdictional areas within the proposed power plant site is estimated to be 2 acres (0.8 hectare) of low-quality wetland, 0.1 acre (0.04 hectare) of moderate-quality wetland, and 18 acres (7.3 hectares) of low-quality ponds of questionable jurisdictional status. The jurisdictional status of these sediment ponds will depend upon the final disposition of the ponds following mining activity. If they are to remain as permanent impoundments, they would be jurisdictional. If they are to be removed following mine use, they would be temporary water treatment ponds and not subject to jurisdiction with the exception of the original creek channel.

The proposed Jewett Power Plant Site is located outside of the FEMA's 100- and 500-year floodplain boundaries.

Sequestration Site

NWI mapping indicates over 43 potential jurisdictional wetlands at the proposed sequestration site, including those associated with major watershed features such as rivers, lakes, and sloughs. These areas, however, are subject to field verification to verify their existence and identify any potential additional wetlands not included in the NWI mapping.

Impacts are not anticipated to these wetlands because the three proposed injection wells and associated disturbance could be placed to avoid wetland locations. Additionally, while the sequestration site is located within the 100-year floodplain, the construction of the injection wells would not directly impact the floodplain.

Utility Corridors

NWI mapping indicates no areas of wetlands within the proposed water supply pipeline corridor; however, this finding is subject to field verification (wetland delineation). The mapping also indicated that segments of all six proposed CO_2 pipeline corridors cross numerous stream channels (see Section 6.7) which include over 90 potential jurisdiction areas (forested, scrub-shrub, and emergent wetlands). These areas, however, are subject to field verification to verify their existence and identify any potential additional wetlands not included in the NWI mapping.

Temporary disturbances to these wetlands would result from construction equipment access and trenching of underground utilities; however, use of directional drilling would avoid impacts. Any impacts to wetlands that could not be avoided by use of existing corridors or directional drilling could be mitigated in-place, in-kind by replacing soil and planting appropriate vegetation. The impacts of this construction would be minimized by using standard pipeline construction methods, including sedimentation and erosion controls. The wetlands would be restored to their existing condition following construction.

Construction would only occur within the 100-year floodplain boundary in the areas located along the CO_2 pipeline corridor. Construction would require heavy and light construction equipment, and small vehicles and implements. Temporarily adding or excavating fill during construction within the floodplain would have no permanent impact on the lateral extent, depth, or duration of flooding in the floodplain areas traversed. Construction within floodplain areas would not result in increases of the 100-year flood elevation by any measurable amount because the floodway is unconstrained and there are no barriers to floodflow passage. The proposed water supply corridor is outside the 100- and 500-year floodplains.

Mitigation and protection measures to minimize direct impacts would include standard stormwater controls such as interceptor swales, erosion control compost, waddles, sod, diversion dikes, rock berms, silt fences, hay bales, or other erosion controls as necessary and as required by USACE permits.

Depending upon final site design and construction activities, other federal, state, and local authorities may have jurisdiction over dredging, filling, grading, paving, excavating, or drilling in the floodplain that would require permits. The USACE has authority to regulate the discharge of dredged or fill materials into waterways and adjacent wetlands through Section 404. Concurrent with its review of the proposed FutureGen Project to determine appropriate National Environmental Policy Act (NEPA) requirements, DOE would also determine the applicability of the floodplain management and wetlands protection requirements contained within 10 CFR Part 1022.

Transportation Corridors

No new transportation corridors are proposed outside of the proposed power plant site footprint. As such, the potential impacts from project construction are discussed under the proposed power plant site. Any unforeseen upgrades or new transportation corridors would require a separate analysis.

6.8.3.2 Operational Impacts

Power Plant Site

Operation of the proposed power plant would have no impact on wetlands or floodplains. All activities associated with the proposed power plant would occur on previously disturbed surfaces outside of wetland and floodplain areas.

Sequestration Site

Operations at the proposed sequestration site would have no impact on wetlands or floodplains. All activities would be outside of wetland and floodplain areas.

Utility Corridors

This operational maintenance of ROW would shift, to a small extent, the balance of wildlife habitat in the area away from wetland and forest toward shrub and brushland. During the permitting process, an acceptable wetland functional assessment methodology would be used to determine the loss of function resulting from the proposed impacts, including any wetland conversions resulting from ROW maintenance. The resulting vegetation communities on the proposed site and associated corridors would be similar to those on other ROWs in the vicinity. Maintenance within the utility corridors would likely be conducted using mechanical (e.g., cutting and mowing) and chemical (e.g., herbicides) means. Applying certain herbicides in proximity to streams and wetlands could constitute a damaging indirect effect on vegetation and aquatic resources. Following approved herbicide usage instructions, however, would likely reduce this concern. The proposed corridors would be allowed to revegetate with no impact from project operations to wetlands and floodplains.

Transportation Corridors

Operation of the proposed power plant would use existing transportation corridors, and therefore, would have no impact on wetlands or floodplains. Any upgrades to existing corridors would require a separate analysis.

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6.9 BIOLOGICAL RESOURCES

6.9.1 INTRODUCTION

This section discusses both aquatic and terrestrial vegetation and habitats, as well as threatened, endangered, and protected species***, including migratory birds*****,** identified in the affected environment that may be impacted by the construction and operation of the proposed FutureGen Project.

6.9.1.1 Region of Influence

The ROI for biological resources is defined as 5 miles (8 kilometers) surrounding the proposed power plant site, sequestration site, and utility corridors.

6.9.1.2 Method of Analysis

DOE reviewed the results of research and studies compiled in the Jewett EIV (FG Alliance, 2006c) to characterize the affected environment. This information included data on wetland, aquatic, and threatened and endangered species. DOE also conducted site visits in August and November 2006, which provided additional information related to the affected environment.

DOE assessed the potential for impacts based on whether the proposed FutureGen Project would:

- Cause displacement of terrestrial communities or loss of habitat;
- Diminish the value of habitat for wildlife or plants;
- Cause a decline in native wildlife populations;
- Interfere with the movement of native resident or migratory wildlife species;
- Conflict with applicable management plans for wildlife and habitat;
- Cause the introduction of noxious or invasive plant species;
- Alter drainage patterns causing the displacement of fish species;
- Diminish the value of habitat for fish species;
- Cause a decline in native fish populations;
- Interfere with the movement of native resident or migratory fish species;
- Conflict with applicable management plans for aquatic biota and habitat;
- Cause loss of a wetland habitat;
- Cause the introduction of non-native wetland plant species;
- Affect or displace special status species; and
- Cause encroachment on or affect designated critical habitat.

6.9.2 AFFECTED ENVIRONMENT

6.9.2.1 Vegetation

Aquatic

Power Plant Site

The only surface waters on the proposed power plant site are three small creeks and a few man-made holding ponds. No major creeks, rivers, or large impoundments are located within the immediate area, although two arms of Lake Limestone are within the outskirts of the ROI. Previous aquatic surveys outside of the proposed power plant site were conducted on behalf of the Jewett Lignite Mine within the ROI. These surveys provide aquatic habitat information that is comparable to what is expected within the creeks and man-made holding ponds on site. These surveys indicate that aquatic macrophytes within perennial streams and ponded areas in streams include seedbox (*Ludwigia* sp.) and pondweed (*Potamogeton* sp.). In general, the abundance of instream macrophytes is greater during the fall than in spring. Canopy cover at most sampling locations was dense with 60 to 90 percent cover. Macrophyte growth is common to abundant in ponds, generally consisting of wetland vegetation such as rushes and water-willows.

Sequestration Site

Numerous ephemeral streams occur at the proposed Jewett sequestration site. Fast-growing, opportunistic macrophytes should be expected when flow is present. Possible opportunistic taxa include alligator weed (*Alternanthera philoxeroides*) and seedbox. Permanent creeks and riverine habitat are also found in the area. Macrophytes expected to occupy such areas include alligator weed, long-leaf pondweed (*Potamogeton nodosus*), seedbox, arrowhead (*Sagittaria calycina* var. *calycina)*, and pickerel weed (*Pontederia cordata*).

Lakes are also present at the sequestration site and should contain macrophyte communities similar to those found in streams. Emergent species occurring in the littoral zone may include alligator weed, bulrush (*Scirpus validus*), and arrowhead. White water lilies (*Nymphaea* spp.) and American lotus (*Nelumbo hutea)* would be expected to occur in deeper waters away from the shore. This profundal zone (depths greater than 33 feet [10.1 meters]) would support elodea, pondweed, and coontail (*Ceratophyllum demersum*). Backwater sloughs and marshes associated with the river and lakes should have similar species to those found along the margins of creeks.

Utility Corridors

Surface waters crossed by the proposed utility corridors are listed and described in Section 6.7. No aquatic habitat is evident along the water supply pipeline corridor; therefore, no aquatic plants would be expected to occur.

There are six segments in the proposed potential CO_2 pipeline corridors. Aquatic vegetation would be expected to occur within them as follows.

Segment A-C of the proposed CO_2 pipeline corridor lies entirely within Freestone County. This segment crosses 14 intermittent stream channels. Because all aquatic habitat along this corridor has intermittent hydrological regimes (wet periods), any emergent macrophytes found here would be fast-growing and likely arise from roots or rhizomes. Possible opportunistic taxa include alligator weed and seedbox.

Segment B-C lies within Freestone and Leon counties. This segment crosses nine intermittent stream channels. Any emergent aquatic plants occurring along these channels would have characteristics similar to those discussed for Segment A-C.

Segment C-D lies entirely within Freestone County. In addition to crossing 16 intermittent channels, this segment traverses three perennial streams. Limitations for macrophyte growth in intermittent streams would be similar to those discussed for Segment A-C. While emergent aquatic plants in perennial streams may not be seasonally restricted by water availability, their growth may be controlled by available sunlight. Aquatic macrophytes found within perrenial streams include elodea (*Anarchis* spp.), arrowhead, and pickerel weed. Spikerushes (*Eleocharis* spp.), rushes (*Juncus* spp.), and sedges (*Carex* spp.) may occur along stream margins.

Segment D-F lies entirely within Freestone County. This segment crosses four perennial and three intermittent streams. Aquatic macrophyte communities occurring in the intermittent and perennial streams would be similar to those discussed for Segments A-C and C-D, respectively.

Segment F-G lies entirely within Freestone County. This segment crosses two perennial creeks and four intermittent channels. Aquatic macrophyte communities occurring in the intermittent and perennial streams would be similar to those discussed for Segments A-C and C-D. Additionally, a small lake occurs along the corridor. Emergent aquatic plants growing in the limnetic zone could include arrowhead, pickerel weed, delta arrowhead (*Sagittaria platyphylla*), and bulrush. In deeper waters of small ponds where sunlight is not limited, white water lily and American lotus may occur. True floating plants such as duckweed (*Lemna* spp.) and water hyacinth (*Eichornia* spp.) could be found in open waters of the lake.

Segment F-H lies within Freestone and Anderson counties. This segment crosses four intermittent streams and traverses the Trinity River, the perennial Edwards Creek, and Cedar Lake Slough. Emergent aquatic plants in the intermittent streams would have characteristics similar to those discussed for Segment A-C. Aquatic plants growing along the margins of the Trinity River would be similar to those found in perennial streams. These may include elodea, arrowhead, pickerel weed, smartweed (*Polygonum* spp.) and long-leaf pondweed. Additionally, backwater sloughs may provide habitat for seedbox, rushes, or common cattail (*Typha latifolia*).

Transportation Corridors

Because no new transportation corridors are proposed outside of the power plant site, this section does not include a description of the affected aquatic environment. Any potential upgrades to existing transportation corridors are anticipated to occur in existing maintained ROWs.

Terrestrial

Power Plant Site

The proposed power plant site and its ROI are located in Limestone, Leon, and Freestone counties, and within the Post Oak Savannah Vegetational Area of Texas (FG Alliance, 2006c). The Post Oak Savannah Vegetational Area occurs on gently rolling to hilly terrain and receives an average of 35 to 45 inches (89 to 114 centimeters) of rain per year (FG Alliance, 2006c). Originally, the two dominant tree species, post oak (*Quercus stellata*) and blackjack oak (*Q. marilandica*), were scattered throughout tallgrass prairies. The suppression of natural fires and other anthropogenic disturbances, however, have contributed to the development of oak and hickory (*Carya* spp.) thickets, which are now dispersed among improved or native pastures. Although the region was extensively cropped until the 1940s, many areas have returned to native vegetation or been developed into managed pastures for livestock operations (FG Alliance, 2006c). Common groundcover species under the woodland canopy or in the interspersed grasslands include little bluestem (*Schizachyrium scoparium*), indiangrass (*Sorghastrum nutans*), purpletop (*Tridens flavus*), silver bluestem (*Bothriochloa saccharoides*), Texas wintergrass (*Stipa leucotricha*), and *Chasmanthium* spp. (FG Alliance, 2006c).

The dominant vegetation types on the proposed power plant site include Post Oak Woods/Forest and Grassland Mosaic and Post Oak Woods/Forest (FG Alliance, 2006c). Characteristic species of these communities include post oak, blackjack oak, eastern red cedar (*Juniperus virginiana*), honey mesquite (*Prosopis glandulosa*), black hickory (*Carya texana*), live oak (*Quercus virginiana*), cedar elm (*Ulmus* *crassifolia*), hackberry (*Celtis laevigata*), yaupon (*Ilex vomitoria*), American beautyberry (*Callicarpa americana*), supplejack (*Berchemia scandens*), greenbriar (*Smilax* sp.), little bluestem, silver bluestem, sand lovegrass (*Eragrostis trichodes*), beaked panicum (*Panicum ancepts*), three-awn (*Aristida* sp.), green sprangletop (*Leptochloa dubia*), and tickclover (*Desmodium* sp.) (FG Alliance, 2006c).

Much of the ROI includes portions of the Jewett Mine, where mine owners have previously conducted detailed vegetation studies. Data collected from these studies indicate that the predominant vegetation type is Upland Hardwood Forest (47 percent), followed by Grasslands (44 percent), Bottomland/Riparian Forest (5 percent), Hydric Habitat (3 percent), and Aquatic Habitat (1 percent). Upland Woodland Forest includes post and blackjack oak, black hickory, winged elm (*Ulmus alata*), sassafras (*Sassafras albidum*) and eastern red cedar. Understory vegetation consists of yaupon, American beautyberry, greenbriar, and wild grapes (*Vitis* spp.) Prairie grasses common to the area are indiangrass, little bluestem, silver bluestem, Texas wintergrass, switchgrass (*Panicum virgatum*), purpletop, and beaked panicum (*Panicum anceps*). Forbs frequently found in climax prairies include crotons (*Croton* spp.), prairie clovers (*Petalostemon* sp.), lespedezas (*Lespedeza* spp.), western ragweed (*Ambrosia psilostachya*), and sneezeweeds (*Helenium* spp.). Much of the grassland community has been converted to improved pasture grasses for grazing or hay production. Typical species in the improved pastures include bermudagrass (*Cynodon dactylon*), dallisgrass (*Paspalum dilatatum*), St. Augustine (*Stenotaphrum secundatum*), and bahiagrass (*Paspalum notatum*). Water oak (*Quercus nigra*), cedar elm, American elm (*Ulmus americana*), black gum (*Nyssa sylvatica*), river birch (*Betula nigra*), box elder (*Acer negundo*), pecan (*Carya illinioensis*), and Carolina basswood (*Tilia caroliniana*) are the predominant tree species found in the riparian woodlands. Common understory and shrubs include deciduous holly (*Ilex decidua*), coralberry (*Symphiocarpus orbiculatus*), red mulberry (*Morus rubra*), flowering dogwood (*Cornus florida*), American holly (*Ilex americana*), and eastern redbud (*Cercis canadensis*). Groundcover is dominated by small-flowered creek oats (*Chasmanthium sessiliflorum*), poison ivy (*Toxicodendron radicans*), peppervine (*Ampleopsis arborea*), and Virginia creeper (*Parthenocissus quinquefolia*).

Sequestration Site

The predominant vegetation types found at the sequestration site are Post Oak Woods/Forest, Post Oak Woods/Forest and Grassland Mosaic, and Water Oak-Elm-Hackberry Forest.

Utility Corridors

The proposed water supply pipeline corridor lies within Freestone and Limestone counties. The predominant vegetation types within the proposed water supply pipeline corridor are Post Oak Woods/Forest and Post Oak Woods/Forest and Grassland Mosaic, which are described above.

Segment A-C of the proposed CO_2 pipeline corridor lies entirely within Freestone County. Segment B-C of the proposed CO_2 pipeline corridor lies within Freestone and Leon counties. Segment C-D of the proposed CO_2 pipeline corridor lies entirely within Freestone County. The predominant vegetation types within these corridors are the previously described Post Oak Woods/Forest and Post Oak Woods/Forest and Grassland Mosaic.

Segments D-F and F-G of the proposed CO_2 pipeline corridor lie entirely within Freestone County. Water Oak-Elm-Hackberry Forest and the previously described Post Oak Woods/Forest are the primary vegetation types within these corridors. The Water Oak-Elm-Hackberry Forest occurs primarily in the upper floodplains of the Sabine, Neches, Sulphur, and Trinity rivers and their tributaries. The dominant species in this mosaic are water oak, water elm (*Planera aquatica*), and hackberry. Commonly associated species include cedar elm, American elm, willow elm, willow oak (*Quercus phellos*), southern red oak

(*Q. falcate*), white oak (*Q. alba*), black oak (*Quercus* sp.), black willow (*Salix nigra*), cottonwood (*Populus deltoides*), red ash (*Fraxinus pensylvanica*), sycamore (*Platanus occidentalis*), pecan, bois d'arc (*Manclura pomifera*), flowering dogwood (*Cornus florida*), dewberry (*Rubus* sp.), coral-berry (*Symphoricarpos orbiculatus*), dallisgrass, switchgrass, rescuegrass (*Bromus unioloides*), bermudagrass, eastern gamagrass (*Tripsacum dactyloides*), Virginia wildrye (*Elymus virginicus*), johnsongrass (*Sorghum halepense*), giant ragweed (*Ambrosia trifida*), and yankeeweed (*Eupatorium compositifolium*).

Segment F-H of the proposed CO_2 pipeline corridor lies within Freestone and Anderson counties. The principal vegetation types occurring in the corridor are the previously described Post Oak Woods/Forest and Grassland Mosaic, and Water Oak-Elm-Hackberry Forest.

Transportation Corridors

Because no new transportation corridors are proposed outside of the power plant site, this section does not include a description of the affected terrestrial environment. Any potential upgrades to existing transportation corridors are anticipated to occur in existing maintained ROWs.

6.9.2.2 Habitats

Aquatic

Power Plant Site

Aquatic invertebrates expected to be found in the streams and ponds of the proposed power plant site; proposed CO_2 pipeline segments C-D, D-F, F-G, and F-H; and the ROI include a variety of insects, crustaceans, mollusks, and segmented worms. Aquatic crustaceans common to streams in the Trinity and Brazos River Drainage Basins include crayfish, freshwater prawns, and planktonic forms such as water fleas (Cladocera). Gastropod mollusks frequently encountered in central Texas include the genera *Physella* (Physidae) and *Helisoma* (Planorbidae). Several bivalve taxa, including the invasive Asiatic clam (*Corbicula fluminea*) are also expected. Annelid or segmented worms, such as oligochaetes and leeches, are found in most freshwater systems along with the larval forms of many insects. No fish are expected to occur within the three streams because they are intermittent. Any fish species found within the man-made impoundments on the proposed power plant site would be the result of land-owner stocking. No formalized federal, state, or local jurisdiction management plans are present.

Scientists studying the Jewett Mine previously conducted invertebrate surveys for a much larger region than the proposed power plant site, encompassing a portion of the ROI. These invertebrate samples were collected during the fall of 1991 and 1994; and spring of 1992 and 1994 (FG Alliance, 2006c). Table 6.9-1 provides a combined list of invertebrate species collected during these field surveys. The three small intermittent creeks and man-made impoundments found on the proposed power plant site and the perennial streams crossed by the proposed CO_2 pipeline segments are likely to contain a smaller diversity of species than found on this list; however, the entire ROI area is likely to contain additional aquatic invertebrate species.

Table 6.9-1. Aquatic Invertebrates Collected from Creeks within the ROI

Family	Genus
Annelida	
Oligochaeta (aquatic earthworms)	
Lumbricidae[1]	
Tubificidae[1]	
Tubificidae	*Limnodrilus*
Hirudinea (leeches)	
Hirudinidae	*Macrobdella*
Mollusca	
Bivalvia (clams/mussels)	
Sphaeriidae	*Corbicula*
Unionidae[1]	
Gastropoda (snails)	
Planorbidae	*Biomphalaria*
Planorbidae	*Helisoma*
Planorbidae	*Gyraulus*
Physidae	*Physa*
Physidae	*Physella*
Ancylidae	
Arthropoda, Class Insecta	
Collembola (springtails)	
Entomobryidae	*Cyphoderus*
Ephemeroptera (mayflies)	
Baetidae	*Baetis*
Caenidae	*Caenis*
Ephemerelliidae	*Ephemerella*
Ephemeridae	*Hexagenia*
Heptageniidae[1]	
Tricorythidae	*Leptohpyhes*
Odonata (dragonflies/damselflies)	
Coenagrionidae	*Argia*
Coenagrionidae	*Amphiagrion*
Lestidae	*Lestes*
Calopterygidae	*Calopterx*
Corduliidae	*Macromia*
Gomphidae	*Dromogomphus*

Table 6.9-1. Aquatic Invertebrates Collected from Creeks within the ROI

Family	Genus
Gomphidae	*Erpetogomphus*
Gomphidae	*Gomphus*
Gomphidae	*Promogomphus*
Libellulidae	*Celithemis*
Libellulidae	*Dythemis*
Libellulidae	*Leucorrhinia*
Libellulidae	*Macrothemis*
Libellulidae	*Miathyria*
Corduliidae	*Neurocordulia*
Macromiidae	*Macromia*
Hemiptera (true bugs)	
Belostomatidae	*Abedus*
Belostomatidae	*Belostoma*
Corixidae	*Hesperocoriza*
Gerridae	*Metobates*
Mesoveliidae	*Mesovelia*
Nepidae	*Ranata*
Notonectidae	*Notonecta*
Vellidae	*Rhagovelia*
Trichoptera (caddisflies)	
Hydropsychidae	*Arctopsyche*
Hydroptilidae[1]	
Leptoceridae	*Oecetis*
Coleoptera (beetles)	
Dytiscidae	*Pachydrus*
Chrysomelidae[1]	
Elmidae	*Dubiraphia*
Elmidae	*Stenelmis*
Gerridae	*Dineutus*
Gyrinidae	*Gyrinus*
Noteridae	*Hydrocanthus*
Haliplidae	*Peltodytes*
Hydrophilidae	*Berosus*
Hydrophilidae	*Troposternus*
Diptera (flies)	
Ceratopogonidae[1]	

Table 6.9-1. Aquatic Invertebrates Collected from Creeks within the ROI

Family	Genus
Chironomidae	*Tanyponida*
Chironomidae	*Chironomus*
Chironomidae	*Kiefferulus*
Chironomidae	*Microtendipes*
Chironomidae	*Pentaneura*
Culicidae[1]	
Tabanidae	*Chrysops*
Tanyderidae[1]	
Lepidoptera (moths/butterflies)	
Pyralidae	*Crambus*
Arthropoda, Subphylum Crustacea	
Decapoda (crayfish/shrimp/crabs)	
Cambaridae	*Procambarus*
Palaemonidae	*Machrobrachium*
Palaemonidae	*Palaemonetes*
Amphipoda (scuds)	
Taltridae	*Hyallela*
Mysidacea (opossum shrimps)	
Mysidae[1]	
Isopoda (aquatic sow bugs)	
Sphaeromatidae[1]	*Thermosphaeroma*

[1] These organisms were identified to the lowest practical taxonomic level.
Source: FG Alliance, 2006c

Sequestration Site

Surface water bodies are located on the sequestration site. Aquatic organisms that inhabit lentic or still waters are generally adapted for that habitat. Many are surface dwellers that do not require highly oxygenated waters. These include whirligig beetles (Gyrinidae), water striders (Gerridae) and other skating "bugs," and larval mosquitoes (Culicidae). Although there are some strong lentic swimmers (Coleoptera, Hemiptera, some Ephemeroptera), most forms are not nektonic (i.e., swimming through the water constantly); instead, the majority are tied to the limnetic zone and emergent plants found there. Although the occurrence of water in such channels is unpredictable, on occasion they provide aquatic habitat for invertebrates. Ephemeral bodies of water can form in low-lying areas of compacted soils during periods of heavy rain. Aquatic invertebrates often take advantage of such conditions to reproduce.

Winged adults with rapid life cycles lay eggs in temporary waters when available. These include flies (Diptera), mosquitoes (Culicidae), biting midges (Ceratopogonidae), and some beetles (Coleoptera). The eggs of many midges (Chironomidae) and mayflies (Ephemeroptera) "oversummer" in low-lying areas where water collects during the wet season. Similarly, immature microcrustaceans, Ostracoda, Cyclopoida, and Amphipoda are able to survive for months in the top layer of a dry stream bed (FG Alliance, 2006c).

In the northern portion of the sequestration site, the combination of habitats includes a major river (the Trinity), major creeks such as Edwards, Indian, Gaston Branch, and Spring creeks, and large impoundments or archaic channel lakes such as Indian Lake, Blue Lake, Cedar Creek Slough, Big Lake, and Spring Lake. Additionally, numerous small "lakes" (sloughs) and ponds occur throughout this portion of the land area. The larger creeks, the Trinity River, and many of the sloughs formed in archaic stream channels could contain a very high percentage of the fish identified in Table 6.9-2. Additionally, many mainstream river species and species attaining large size could be found in such habitats. Gar, drum, carp, catfish, buffalo, and suckers are all species typically attaining body sizes requiring larger, more permanent bodies of water to inhabit. Commercial fishing for many of these species could occur in these areas. Bass, catfish, and numerous sunfish species provide recreational fishing opportunities as well.

The southern portion of the sequestration site provides a small area of habitat for fish species described for the northern portion of the ROI and the proposed power plant site and includes the upstream extent of Brinkley Creek, Indian Creek, and Gaston Creek. However, the majority of the area is drained by Upper Keechi Creek and its major tributaries, including Jelly Slough, Holly Branch, Plum Creek, Dowdy Creek, and Negro Creek. All of these perennial streams provide intermediate-sized habitat for fish. Some smaller lakes and ponds such as Red Lake, Little Red Lake, and Burleson Lake are found in this reach. These are generally more isolated water bodies without mainstream connections, and thus would likely support a more farm pond type species complex perhaps consisting of bass, catfish, sunfish, and forage species. Overall, the species complex in the streams would more likely resemble the proposed power plant site and its immediately adjacent construction corridors in that local fish communities would be represented by several minnow species and sunfish species with a few bass and catfish individuals added. No recreational fishery or commercial fishery exists in this area of the ROI above the sequestration reservoir. No formalized federal, state, or local jurisdiction management plans are present.

Table 6.9-2. Fish Species Whose Geographic Distribution Includes the Proposed Power Plant Site

Family Scientific Name	Common Name	Collected from the Proposed Power Plant Site Area
Petromyzontidae	Lampreys	
Ichthyomyzon gagei	southern brook lamprey	
Polyodontidae	Paddlefishes	
Polyodon spathula	Paddlefish	
Lepisosteidae	Gars	
Lepisosteus oculatus	spotted gar	X
Lepisosteus osseus	longnose gar	
Amiidae	Bowfin	
Amia calva	Bowfin	X
Anguillidae	Eels	
Anguilla rostrata	American eel	

Table 6.9-2. Fish Species Whose Geographic Distribution Includes the Proposed Power Plant Site

Family Scientific Name	Common Name	Collected from the Proposed Power Plant Site Area
Clupeidae	Herrings	
Dorosoma petenenese	threadfin shad	X
Dorosoma cepedianum	gizzard shad	X
Esocidae	Pike	
Esox americanus vermiculatus	grass pickerel	X
Cyprinidae	Minnows	
Cyprinus carpio	common carp	X
Carassius auritus	Goldfish	
Notemigonus crysoleucas	golden shiner	X
Opsopoeodus emiliae	pugnose minnow	X
Macrohybopsis aestivalis	speckled chub	
Phenacobius mirabilis	suckermouth minnow	X
Lythrurus fumeus	ribbon shiner	X
Lythrurus umbratilis	redfin shiner	X
Cyprinella venusta	blacktail shiner	X
Cyprinella lutrensis	red shiner	X
Notropis atherinoides	emerald shiner	X
Notropis shumardi	silverband shiner	X
Notropis texanus	weed shiner	
Notropis amnis	pallid shiner	
Notropis atrocaudalis	blackspot shiner	X
Notropis volucellus	mimic shiner	
Notropis buchanani	ghost shiner	X
Hybognathus nuchalis	Mississippi silvery minnow	
Pimephales vigilax	bullhead minnow	X
Catostomidae	Suckers	
Cycleptus elongates	blue sucker	
Ictiobus bubalus	Smallmouth buffalo	X
Ictiobus niger	black buffalo	
Carpiodes carpio	river carpsucker	
Moxostomacongestum	gray redhorse	
Minytrema melanops	spotted sucker	X
Erimyzon sucetta	lake chubsucker	X

Table 6.9-2. Fish Species Whose Geographic Distribution Includes the Proposed Power Plant Site

Family Scientific Name	Common Name	Collected from the Proposed Power Plant Site Area
Ictaluridae	Catfishes	
Ictalurus punctatus	channel catfish	X
Ictalurus furcatus	blue catfish	
Ameiurus melas	black bullhead	X
Ameiurus natalis	yellow bullhead	X
Pylodictis olivaris	flathead catfish	
Noturus gyrinus	tadpole madtom	X
Noturus nocturnes	freckled madtom	
Aphredoderidae	pirate perch	
Aphredoderus sayanus	pirate perch	X
Fundulidae	Topminnows	
Fundulus dispar	starhead topminnow	X
Fundulus notatus	Blackstripe topminnow	X
Fundulus olivaceus	blackspotted topminnow	X
Poeciliidae	Livebearers	
Gambusia affinis	western mosquitofish	X
Atherinopsidae	New World silversides	
Menidia beryllina	inland silverside	X
Moronidae	Temperate basses	
Morone chrysops	white bass	
Centrarchidae	Sunfish	
Micropterus punctulatus	spotted bass	
Micropterus salmoides	Largemouth bass	X
Lepomis gulosus	Warmouth	X
Lepomis cyanellus	green sunfish	X
Lepomis symmetricus	bantam sunfish	
Lepomis punctatus	spotted sunfish	X
Lepomis microlophus	redear sunfish	X
Lepomis macrochirus	Bluegill	X
Lepomis humilis	orangespotted sunfish	X
Lepomis auritus	redbreast sunfish	
Lepomis megalotis	longear sunfish	X
Lepomis marginatus	dollar sunfish	X
Pomoxis annularis	white crappie	X

Table 6.9-2. Fish Species Whose Geographic Distribution Includes the Proposed Power Plant Site

Family Scientific Name	Common Name	Collected from the Proposed Power Plant Site Area
Pomoxis nigromaculatus	black crappie	X
Elassoma zonatum	banded pygmy sunfish	X
Percidae	Perch	
Percina sciera	dusky darter	X
Percina macrolepida	bigscale logperch	X
Ammocrypta vivax	scaly sand darter	X
Etheostoma chlorosomum	bluntnose darter	X
Etheostoma gracile	slough darter	X
Etheostoma parvipinne	goldstripe darter	X
Sciaenidae	drums and croakers	
Apolodinotus grunniens	Freshwater drum	

Source: FG Alliance, 2006c.

Utility Corridors

Aquatic invertebrates expected in the streams and ponds of the proposed CO_2 pipeline segments C-D, D-F, F-G, and F-H include a variety of insects, crustaceans, mollusks, and segmented worms.

Proposed CO_2 pipeline segment F-H crosses the Trinity River and connects with the land above the sequestration reservoir. Although large rivers provide some habitat for aquatic insects, available microhabitat is not especially diverse and taxa richness is generally low (FG Alliance, 2006c). Insect taxa adapted to large rivers and their adjoining channels include burrowing mayflies (Ephemeroptera) and mayflies with operculate gills, predacious dragonflies (Odonata), which feed on associated fauna such as riffle beetles (Emidae) and net-spinning caddisflies (Hydropsychidae). Aside from the aquatic insects, other invertebrates such as crustaceans and mollusks are common in large riverine systems. Gastropod mollusks frequently encountered in central Texas include the genera *Physella* (Physidae) and *Helisoma* (Planorbidae). Several bivalve taxa, including the invasive Asiatic clam (*Corbicula fluminea*) are also expected. Crustaceans, such as the river shrimp (*Macrobranchium ohione*), crayfish (*Procambarus* sp.), and freshwater prawns would also be found in abundance. Additionally, annelids such as leeches and oligochaete worms are ubiquitous to aquatic ecosystems in temperate climates.

The proposed process water supply pipeline corridor contains no aquatic habitat and therefore no aquatic invertebrates.

Table 6.9-2 presents fish species likely found within the ROI, including within the proposed utility corridor segments A-C, B-C, C-D, and D-F south of Highway 84. No aquatic habitat is present along the proposed water supply pipeline corridor. At least 71 species have geographic ranges that include the ROI, with 49 species collected from the area. The aquatic habitats found on the proposed power plant site would likely include smaller fish species due to the small nature of the creeks.

The proposed CO_2 pipeline segments D-F north of Highway 84, F-G, and F-H are located either within or very near the floodplain of the Trinity River. Because of this, the perennial creeks in the area are generally larger than those described for the proposed power plant site or the corridor segments to the south of Highway 84. Habitat for the bulk of the species listed in Table 6.9-2 would occur in these areas, except for the speckled chub (*Macrohybopsis aestivalis*) and gray redhorse (*Moxostoma congestum*). The two species listed occur primarily in the Brazos River drainage in this area of Texas. The following additional species not listed in the table would also occur: alligator gar (*Lepisostens spatula*), creek chubsucker (*Erimyzon oblongus*), blacktail redhorse (*Moxostoma poecilurum*), brook silversides (*Labidesthes sicculus*), yellow bass (*Morene mississippiensis*), and flier (*Centrarchus macropterus*).

Intermittent and ephemeral stream channels occur throughout all of the proposed CO_2 pipeline corridors. A small lake occurs within proposed CO_2 pipeline segment F-G. For habitat descriptions, see the above discussion of aquatic habitats in the sequestration site.

No formalized federal, state, or local jurisdiction management plans are present for the proposed utility corridors.

Transportation Corridors

Because no new transportation corridors are proposed outside of the power plant site, this section does not include a description of the affected aquatic environment. Any potential upgrades to existing transportation corridors are anticipated to occur in existing maintained ROWs.

Terrestrial

The proposed power plant site, sequestration site, utility corridors, and ROI lie within the Texan Biotic Province described by Blair (FG Alliance, 2006c). The Texan Biotic Province corresponds to open woodland and savannah vegetational types, as the landscape transitions from the wetter forests in the east toward the slightly drier grassland provinces in the west. The faunal composition of this ecotonal region intermixes species typical of both the Austroriparian forestlands and the grasslands of the Kansan Biotic Province in the Texas Panhandle. This province contains no vertebrate species endemic to this region. It is estimated that 49 species of mammals, 16 species of lizards, 41 species of snakes, two species of turtles, five species of salamanders, and 18 species of frogs and toads occur within the Texan Province (FG Alliance, 2006c).

Reptiles commonly encountered in woodland habitats include the three-toed box turtle (*Terrapene carolina triunguis*), northern fence lizard (*Sceloporus undulatus hyacinthinus*), green anole (*Anolis carolinensis*), five-lined skink (*Eumeces fasciatus*), and Texas rat snake (*Elaphe obsoleta lindheimerii*). Resident avian species found in the upland hardwood forest include the eastern screech owl (*Otus asio*), hairy woodpecker (*Picoides villosus*), pileated woodpecker (*Dryocopus pileatus*), blue jay (*Cyanocitta cristata*), American crow (*Corvus brachyrhynchos*), Carolina chickadee (*Poecile carolinensis*), Carolina wren (*Thryothorus ludovicianus*), and northern cardinal (*Cardinalis cardinalis*); as well as the migratory great-crested flycatcher (*Myiarchus crinitus*), ruby-crowned kinglet (*Regulus calendula*), cedar waxwing (*Bombycilla cedrorum*), and black-and-white warbler (*Mniotilta varia*). Mammals occurring in the upland hardwoods include the Virginia opossum (*Didelphis virginiana*), red bat (*Lasiurus borealis*), nine-banded armadillo (*Dasypus novemcinctus*), eastern fox squirrel (*Sciurus niger*), white-footed mouse (*Peromyscus leucopus*), eastern woodrat (*Neotoma floridana*), common raccoon (*Procyon lotor*), and white-tailed deer (*Odocoileus virginianus*).

Common grassland species include the eastern narrowmouth toad (*Gastrophryne carolinensis)*, pickerel frog (*Rana palustris*), ornate box turtle (*Terrapene ornata ornata*), eastern earless lizard

(*Holbrookia maculata perspicua*), eastern yellowbelly racer (*Coluber constrictor flaviventris*), and Louisiana milk snake (*Lampropeltis triangulum amaura*). Year-round resident bird species include the northern bobwhite, killdeer (*Charadrius vociferous*), inca dove (*Columbina inca*), loggerhead shrike (*Lanius ludovicianus*), lark sparrow (*Passerina ciris*), and eastern meadowlark (*Sturnella magna*). The yellow-billed cuckoo (*Coccyzus americanus*), common nighthawk (*Chordeiles minor*), scissor-tailed flycatcher (*Tyrannus forficatus*), and indigo bunting (*Passerina cyanea*) are summer resident species likely to occur within these habitats. Common mammals include the black-tailed jack rabbit (*Lepus californicus*), fulvous harvest mouse (*Reithrodontomys fulvescens*), hispid cotton rat (*Sigmodon hispidus*), coyote (*Canis latrans*), eastern spotted skunk (*Spilogale putorius*), and white-tailed deer.

No formalized federal, state, or local jurisdiction management plans are present.

6.9.2.3 Federally Listed Threatened and Endangered Species

Based on review of threatened and endangered species databases generated by the Texas Parks and Wildlife Department (TPWD) and FWS, and confirmed by a field reconnaissance that Horizon Environmental Services conducted on behalf of the site proponent in April 2006, there are no protected aquatic species within the proposed power plant site or surrounding area. There are also no federally listed aquatic species located within the proposed water supply or CO_2 pipeline corridors, or the proposed land above the sequestration reservoir. The coordination letters are included in Appendix A.

Although there are no known occurrences of federally listed species within any of the proposed project construction areas, according to FWS, federally listed threatened or endangered terrestrial species which could occur within Anderson, Leon, Limestone, and Freestone counties include the endangered Houston toad (*Bufo houstonensis*), endangered interior least tern (*Sterna antillarum*), threatened bald eagle (*Haliaeetus leucocephalus*), endangered wood stork (*Mycteria americana*), endangered Navasota ladies'-tresses (*Spiranthes parksii*), endangered large-fruited sand verbena (*Abronia macrocarpa),* and threatened tinytim (*Geocarpon minimum*). No designated critical habitat occurs at any of the areas to be affected by construction of the proposed project.

The Houston toad inhabits very deep, friable sands within a variety of associated forest cover types, including loblolly pine and post oak. They breed in shallow bodies of water that persist long enough (30 to 60 days) for egg hatching and metamorphosis to occur. Surveys for the Houston toad within the Jewett Mine site have been conducted on numerous occasions with no observations of the toads. FWS has concurred that the Houston toad is unlikely to occur in the vicinity of the Jewett Mine; therefore, it is unlikely it would occur on the proposed power plant site, utility corridors, or within the ROI. Suitable habitat does exist on the land above the sequestration reservoir.

The interior least tern nests on sandbars, salt flats, and barren shores along wide, shallow rivers. Recently, interior least terns have been documented nesting on both disturbed and reclaimed mine lands at the Jewett Mine. Since 1994, interior least terns have nested on portions of the Jewett Mine (approximately 2 to 3 miles [3.2 to 4.8 kilometers] northeast of the proposed power plant site), except for 1998, when no nesting terns were recorded but a tern was sighted flying above the western portion of a reclaimed area (FG Alliance, 2006c). In addition, during the 2000 breeding season, six pairs (unknown number of fledglings) nested on another site in the same general area. Interior least terns have also nested in mine areas approximately 2 to 3 miles (3.2 to 4.8 kilometers) southwest of the proposed power plant site during 2001 and 2006, and 1.5 to 2.5 miles (2.4 to 4.0 kilometers) southeast of the site in 2001 through 2006 (FG Alliance, 2006c). Although no interior least tern nesting habitat is present on the proposed power plant site, potential habitat is present within the proposed utility corridors and the land above the sequestration reservoir.

No suitable bald eagle habitat is present on the proposed power plant site; however, it is possible that eagles could pass over the site during migration or daily foraging travels. The closest known bald eagle habitat is Lake Limestone, which is located at the edge of the ROI to the southeast and northeast of the proposed power plant site. Wintering bald eagles were observed along the Trinity River near the land above the sequestration reservoir during a November 2006 site visit.

The wood stork is federally listed as endangered and state-listed as threatened. The wood stork formerly bred in southeast Texas, but now only occurs during post-breeding dispersal. Potential habitat for this species includes shallow-water habitats such as pond fringes, marshes, and lake fringes. It could occur in the proposed utility corridors and land above the sequestration reservoir during migration.

Navasota ladies'-tresses are found in sandy loam soils within post oak woodland openings along intermittent tributaries of the Navasota and Brazos rivers. Surveys for the Navasota ladies'-tresses have been conducted since 1991 on the Jewett Mine. This species has been found at various sites within the mine, but none have been reported to occur on the proposed power plant site. Many of the known locations of this species are within the ROI (FG Alliance, 2006c). The closest known location is approximately 3 to 4 miles (4.8 to 6.4 kilometers) to the east of the proposed utility corridors in Leon County. Potential habitat also occurs along the proposed utility corridors and on the sequestration site.

The large-fruited sand verbena occurs in deep sand soils with dune-like characteristics. This habitat does not occur on the proposed power plant site. Surveys for the sand verbena on the Jewett Surface Mine have been negative (FG Alliance, 2006c). It is unlikely this species occurs on the proposed power plant site, the proposed utility corridors, the sequestration site, or within the ROI due to lack of appropriate habitat.

Tinytim is a federally listed threatened plant species that occurs in Anderson County. This inconspicuous member of the pink family (Caryophyllidae) occurs in shallow soils that are rich in sodium or magnesium. Potential habitat occurs on the land above the sequestration reservoir.

6.9.2.4 Other Protected Species

Aquatic Species

Although several rare species of mollusks have been reported in Freestone, Leon, and Limestone counties, none have been identified during surveys previously conducted by Jewett Mine within the ROI (FG Alliance, 2006c). The federal candidate fish species smalleye shiner (*Notropis buccula*), state-listed threatened blue sucker (*Cycleptus elongatus*), state-listed endangered paddlefish (*Polydon spathula*), and state-listed threatened creek chubsucker (*Erimyzon oblongus*) all have ranges that include the proposed power plant site and its ROI; however, no habitat that would support these species exists on the site because no perennial water is present. Additionally, several invertebrate species (13 mussel species, three caddisfly species, and one dragonfly species) designated as rare are found in the counties containing the proposed power plant site, utility corridors, and land above the sequestration reservoir, as listed in Table 6.9-3. Potential habitat only exists within the perennial streams along the proposed CO_2 pipeline corridors and on the land above the sequestration reservoir. Overall, there are no known occurrences of state-listed rare, threatened, or endangered aquatic species.

Terrestrial

State-listed plants and animals that have the potential to occur within Anderson, Freestone, Leon, and Limestone counties include the peregrine falcon (*Falco peregrinus*), Texas horned lizard (*Phrynosoma cornumtum*), timber rattlesnake (*Crotalis horridus*), alligator snapping turtle (*Macrochelys temminckii*), Bachman's sparrow (*Aimophila aestivalis*), and the white-faced ibis (*Plegadis chihi*). None of these species are likely to occur within the proposed power plant site because of lack of suitable habitat or the extirpation of the species in the project area. Habitats within the proposed utility corridors and the sequestration site have the potential to support Bachman's sparrow and the white-faced ibis, both state-listed threatened species. Bachman's sparrow occurs in open pine woods with a scattered brush understory and overgrown fields in Anderson and Freestone counties. The previously described Post Oak Woods/Forest and Grassland Mosaic vegetation type, common in these counties, could provide habitat for this species. The white-faced ibis is found in freshwater marshy habitat or sloughs in Anderson and Limestone counties. Potentially suitable habitat exists within Segments F-G and F-H of the proposed CO_2 pipeline corridor and on the sequestration site. The peregrine falcon and an associated sub-species, the Arctic peregrine falcon (*Falco peregrinus tundrius*), are statewide migrants and may be present for short periods during spring and fall migrations in the proposed utility corridors and the sequestration site (FG Alliance, 2006c). Although potential habitat is present, there are no known occurrences of any state-listed rare, threatened, or endangered species within any of the proposed project construction areas.

Table 6.9-3. Invertebrates Designated as "Rare" by TPWD in Freestone, Leon, Limestone, and Anderson Counties

Common Name	Scientific Name	Counties Listing it as Rare
Creeper (squawfoot)	*Strophitus undulates*	Freestone and Leon
Fawnsfoot	*Truncilla donaciformis*	Freestone and Leon
Little spectaclecase	*Villosa lienosa*	Freestone and Leon
Louisiana pigtoe	*Pleurobema riddellii*	Freestone and Leon
Pistolgrip	*Tritogonia verrucosa*	Freestone, Leon, and Limestone
Rock-pocketbook	*Arcidens confragosus*	Freestone, Leon, and Limestone
Sandbank pocketbook	*Lampsilis satura*	Freestone and Leon
Texas heelsplitter	*Potamilus amphichaenus*	Freestone and Leon
Texas pigtoe	*Fusconaia askewi*	Freestone and Leon
Wabash pigtoe	*Fusconaia flava*	Leon
Smooth pimpleback	*Quadrula houstonensis*	Leon and Limestone
False spike mussel	*Quincuncina mitchelli*	Limestone
Texas fawnsfoot	*Truncilla macrodon*	Limestone
Purse casemaker caddisfly	*Hydroptila ouachita*	Anderson
Holzenthal's philopotamid caddisfly	*Chimarra holzenthali*	Anderson
Morse's net-spinning caddisfly	*Cheumatopsyche morsei*	Anderson
Texas emerald dragonfly	*Somatochlora margarita*	Anderson
Creeper (squawfoot)	*Strophitus undulatus*	Anderson
Fawnsfoot	*Truncilla donaciformis*	Anderson
Little spectaclecase	*Villosa lienosa*	Anderson

Source: FG Alliance, 2006c.

Coordination with the FWS and TPWD did not identify any migratory bird populations that could be affected by the project. However, habitat (i.e., wetlands and riparian corridors) for these populations is present. Therefore, migratory birds could use habitat within the area as stopovers during migration.

6.9.3 IMPACTS

6.9.3.1 Construction Impacts

Power Plant Site

There are three small intermittent tributary streams and three man-made impoundments on the power plant site. Placement of fill during site construction could result in direct permanent impacts to these features. Previous modifications for most of the lengths of two of these streams have degraded habitats to low value. Although the third tributary has not been previously modified, it is ephemeral in nature and considered of moderate value. None of the on-site streams or impoundments are known to contain any habitat or species that are not plentiful in this area of Texas. The Alliance could likely avoid these features during the site layout and planning process. Standard stormwater management practices for construction activities (e.g., placement of silt fencing around disturbed areas) would prevent indirect impacts, such as sedimentation to off-site surface waters.

Project construction would require the removal of up to 200 acres (81 hectares) of terrestrial habitat to accommodate the power plant envelope (plant buildings and associated corridors). This would predominantly consist of post oak woods and grassland habitat, neither of which is rare in the greater project area. Wildlife species found within the construction site are common to the area. Some small, less mobile species, such as reptiles and small mammals, would be lost during project construction; however, this would not affect the overall populations of these species due to their commonality and plentiful alternative habitat. Larger, more mobile species would likely disperse from the project site due to noise, disturbance, and the habitat loss. Because of the adjacent suitable habitat is plentiful, this would not likely affect population health. Additionally, construction of the proposed power plant site is unlikely to cause a proliferation of noxious weeds because the disturbed area would become an industrial facility with little vegetation.

No known federally or state-listed rare, threatened, or endangered species, or designated critical habitat, are located at the proposed power plant site. However, the federally listed Navasota ladies'-tresses could potentially occur on the proposed power plant site. Should this species occur within the area of construction, it could sustain direct impacts in the absence of enforced protection measures. Protocol-level surveys for the Navasota ladies'-tresses before commencement of any ground-disturbing activities at the proposed power plant site would confirm its presence or absence. If the species is found in proximity to any construction or disturbance area, consultation between the site proponent, the TPWD, and the FWS to develop and implement species protection plans would avoid direct or indirect impacts, such as casualty or habitat loss.

Sequestration Site

The proposed sequestration site contains numerous perennial, intermittent, and ephemeral stream channels, as well as a larger lake. Placement of the three proposed injection wells would likely avoid these locations to minimize impacts. Construction of the injection wells would disturb up to 10 acres (4 hectares) of land. However, this disturbance should not affect the overall extent and availability of terrestrial resources dispersed throughout the site. After construction, disturbed areas not used for injection wells would be revegetated with native species, limiting the proliferation of noxious weeds.

Temporary impacts to vegetation would result from truck access during the required seismic surveys of the sequestration site, before injection well construction.

No federally or state-listed rare, threatened, or endangered species are known to occur in the sequestration site. However, the federally listed interior least tern, tinytim, and Houston toad; the state-listed Bachman's sparrow and white-faced ibis; and the state rare invertebrates listed in Table 6.9-3 could potentially occur within the sequestration site. Should any of these species occur within areas of construction, they could sustain direct impacts in the absence of enforced protective measures. The sequestration site does not contain any designated critical habitat. Protocol-level surveys for the interior least tern, Houston toad, Bachman's sparrow, white-faced ibis, and rare invertebrates before commencement of any ground-disturbing activities would confirm the presence or absence of these species. If any of these species are found in proximity to any construction or disturbance area, consultation between the site proponent, the TPWD, and the FWS to develop and implement species protection plans would avoid direct or indirect impacts, such as casualty or habitat loss.

Utility Corridors

The proposed CO_2 pipeline corridors would be between 52 and 59 miles (83.7 and 95 kilometers) long, depending upon which configuration is ultimately built. There are several perennial, intermittent, and ephemeral streams, as well as a small lake along the proposed CO_2 pipeline segments. The perennial streams include the Trinity River. If these utilities are not directionally drilled beneath these features, temporary and minor impacts to aquatic habitat could include trenching of stream and pond beds during construction to accommodate the pipeline. Flow, if present during construction, would be temporarily diverted around the area of installation. Traditional pipeline construction methods, along with appropriate protection and mitigation measures such as time of year construction restrictions, silt fencing, hay bales, and other sediment and erosion control mechanisms, would minimize these effects. The proposed water supply pipeline corridor does not contain aquatic habitat.

Construction of many of the proposed pipelines in existing ROWs would minimize the amount of vegetation and habitat loss. The terrestrial habitat type is similar to that described for the proposed power plant site and does not contain designated critical habitat for federally or state-listed rare, threatened, or endangered species. Similar habitat is plentiful in the project vicinity. The TPWD states that the proposed CO_2 pipeline traverses through high-quality deer and turkey hunting ground, which could be temporarily impacted by pipeline installation. The proposed water supply pipeline corridor would likely be only 0.4 mile (0.6 kilometer) of new ROW. Land above the pipelines would be revegetated with native species following construction, maintaining wildlife habitat similar to current conditions and limiting the proliferation of noxious weeds. Although it is likely that a new transmission line would not need to be built, one option (Option 2) would require 2 miles (3.2 kilometers) of new ROW. Wildlife species found along the proposed utility corridors, like those at the proposed power plant site, are common species that could be temporarily displaced during construction.

No federally or state-listed rare, threatened, or endangered species are known to occur in the project area, and therefore would not be affected. Additionally, there is no designated critical habitat within the proposed utility line corridors. However, the federally listed Navasota ladies'-tresses could potentially occur along the proposed CO_2 pipeline corridors. Should this species occur within the area of construction, it could sustain direct impacts in the absence of enforced protection measures. Additionally, the federally listed interior least tern, the state-listed Bachman's sparrow and white-faced ibis, and the state rare invertebrates listed in Table 6.9-3 have the potential to occur within the proposed CO_2 pipeline corridors. If any of these species occur within the areas of construction they could be directly impacted by the proposed project if protective measures are not taken. Protocol-level surveys would confirm the presence or absence of these species before commencement of any ground-disturbing activities. If any of these species are found in proximity to any construction or disturbance area, consultation between the site proponent, the TPWD, and the FWS to develop and implement species protection plans would avoid direct or indirect impacts, such as casualty or habitat loss.

Construction of the utility corridors could result in temporary impacts to migratory bird habitat. This loss of habitat would have a minimal impact to migratory bird populations as comparable habitat is abundant and available in the overall region.

Transportation Corridors

No new transportation corridors are proposed outside of the proposed power plant site or sequestration site. As such, the potential impacts from project construction are discussed under the proposed power plant site. Any unforeseen major upgrades or new transportation corridors would require a separate analysis.

6.9.3.2 Operational Impacts

Power Plant Site

Operating the proposed power plant would have minimal effect on biological resources. Noise during proposed project facility operations would be slightly elevated in the absence of mitigation (see Section 6.14); however, wildlife species that are found near the proposed power plant site would either adapt to the noise or disperse in the plentiful adjacent habitat. Air emissions due to routine operation would result in small increases in ground-level pollutant concentrations (see Section 6.2 for description) that should be below levels known to be harmful to wildlife and vegetation or affect ecosystems through bio-uptake and biomagnification in the food chain. Because there are no high-quality or sensitive aquatic or wildlife receptors near the proposed power plant site, air emissions would not impact biological communities.

Sequestration Site

A limited number of site characterization seismic surveys would be required during operation of the sequestration site, resulting in temporary impacts to vegetation due to truck access within the survey plots.

Microbes occurring approximately 0.9 mile (1.4 kilometers) under ground within the sequestration reservoir could be affected by sequestration. Microbes are likely to exist in almost every environment, including the proposed sequestration reservoirs, unless conditions prevent their presence. CO_2 sequestration has the potential to destroy these localized microbial communities by altering the pH of the underground environment. However, it is also possible that CO_2 sequestration would not harm microbial communities (IPCC, 2005). The potential loss of localized microbial populations within the sequestration reservoir would not constitute an appreciable difference to the world's total microbial population.

No additional impacts are anticipated during normal operations. Should released gas from the sequestration reservoir reach surface water, impacts to aquatic biota would be unlikely because the concentration of CO_2 in the surface water would be less than the 2 percent level at which effects to aquatic biota could occur (see Section 6.17). Plants ***and animals*** are not predicted to be impacted by gradual CO_2 releases from the sequestration reservoir, although effects in the immediate vicinity of the injection wells could result from a rapid CO_2 release (see Section 6.17). ***If there were upward migration of the sequestered gas, the H_2S within the gas would diffuse in the subsurface and react with the rock formations, which would minimize or eliminate its release to the atmosphere. Therefore, migration of***

H_2S into shallow soils at concentrations harmful to burrowing animals and other ecological receptors is not likely.

Utility Corridors

The proposed water supply and CO_2 pipeline corridors would be maintained without trees due to safety concerns. Corridor maintenance would likely use both mechanical (e.g., cutting and mowing) and chemical (e.g., herbicides) means. Applying certain herbicides in close proximity to streams and wetlands could be potentially damaging. Following approved herbicide usage instructions would eliminate this concern (DOE, 2007). If a leak or rupture in the CO_2 pipeline occurred, respiratory effects to biota due to atmospheric CO_2 concentrations would be limited to the immediate vicinity along the pipeline where the rupture or leak occurred. While heat generated from the supercritical fluid in the CO_2 pipeline could potentially affect surface vegetation, pipeline construction techniques that would contain the heat through insulation and installation depth would prevent this impact. Soil gas concentrations vary depending on soil type; therefore, effects on soil invertebrates or plant roots could occur close to the segment of pipeline that ruptured or leaked (see Section 6.17).

Transportation Corridors

Other than a potential minimal increase in road kill, there would be no impact to biological resources due to increased traffic on existing roads and the new transportation spurs located at the proposed power plant site.

6.10 CULTURAL RESOURCES

6.10.1 INTRODUCTION

Section 106 of the National Historic Preservation Act of 1996 (NHPA) and its implementing regulations at 36 CFR Part 800 (incorporating amendments effective August 5, 2004) require federal agencies to take into account the effects of their undertakings on historic properties, and afford the Advisory Council on Historic Preservation (ACHP) a reasonable opportunity to comment on such undertakings.

Historic properties are a specific category of cultural resources. Cultural resources are any resources of a cultural nature (King, 1998). As defined at 36 CFR 800.16[l][1], a historic property is a cultural resource that is any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in, the National Register of Historic Places (NRHP) maintained by the Secretary of the Interior. Historic properties include artifacts, records, and remains related to and located within such properties, as well as properties of traditional religious and cultural importance to Native American tribes or Native Hawaiian organizations, and properties that meet National Register criteria for evaluation (36 CFR 60.4).

36 CFR Part 800 outlines procedures to comply with NHPA Section 106. At 36 CFR Part 800(a), federal agencies are encouraged to coordinate Section 106 compliance with any steps taken to meet NEPA requirements. Federal agencies are to also coordinate their public participation, review, and analysis to meet the purposes and requirements of both NEPA and the NHPA in a timely and efficient manner. The Section 106 process has been initiated for this undertaking with the intent of coordinating that process with DOE's obligations under NEPA regarding cultural resources.

For purposes of this document, cultural resources are:

- Archaeological resources, including prehistoric and historic archaeological sites;
- Historic resources, including extant standing structures;
- Native American resources, including Traditional Cultural Properties (TCPs) important to Native American tribes; or
- Other cultural resources, including extant cemeteries and paleontological resources.

Participants in the Section 106 process include an agency official with jurisdiction over the FutureGen Project, the ACHP, consulting parties, and the public. Consulting parties include the State Historic Preservation Officer; Native American tribes and Native Hawaiian organizations; representatives of local

The **National Historic Preservation Act** of 1966 (16 USC 470), establishes a program for the preservation of historic properties throughout the Nation.

The **National Register** criteria for evaluation states that:

The quality of significance in American history, architecture, archaeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and:

(a) that are associated with events that have made a significant contribution to the broad patterns of our history; or

(b) that are associated with the lives of persons significant in our past; or

(c) that embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

(d) that have yielded, or may be likely to yield, information important in prehistory or history.

government; and applicants for federal assistance, permits, licenses, and other approvals. Additional consulting parties include individuals and organizations with a demonstrated interest in the FutureGen Project due to their legal or economic relation to the undertaking or affected properties, or their concern with effects of the undertakings on historic properties. In Texas, the State Historic Preservation Officer is the executive director of the Texas Historical Commission (THC).

If the proposed project would encompass any state-owned lands or use any public funding supplied by the State of Texas or its subdivisions, the project falls under the jurisdiction of the Antiquities Code of Texas (FG Alliance, 2006c). A building or site listed in the NRHP may also be designated as a State Archaeological Landmark (SAL) by the THC. A cultural resources planning document was published for the Central and Southern Planning Region of Texas (***Miller and Yost, 2006***), but there are currently no published planning documents for the portion of the state in which the proposed Jewett Power Plant Site is located.

6.10.1.1 Region of Influence

The ROI for cultural resources includes (1) the proposed power plant site and area within 1 mile (1.6 kilometers) of the proposed power plant site boundaries; (2) all related areas of new construction and those within 1 mile (1.6 kilometers) of said areas; and (3) the land area above the proposed sequestration reservoir(s). NHPA Section 106 states the correlate of the ROI is the Area of Potential Effects (APE).

> The **Area of Potential Effects** is the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if such properties exist (36 CFR 800.16[d]).

Adverse effects to archaeological, paleontological, and cemetery resources are generally the result of direct impacts from ground disturbing activities. Therefore, the APE for such resources coincides with those areas where direct impacts from the construction and operation of the proposed facility would occur. Adverse effects to historic resources (i.e., standing structures) may occur through direct impacts that could change the character of a property's use or the physical features within a property's setting that contribute to its historic significance. Adverse effects may also occur through indirect impacts that could introduce visual, atmospheric, or audible elements that diminish the integrity of the property's significant historic features. For architectural resources, the APE encompasses the ROI as defined. TCPs may be subject to both direct and indirect impacts.

6.10.1.2 Method of Analysis

DOE reviewed the results of research and studies performed by the Alliance to determine the potential for impacts based on the following criteria:

- Archaeological Resources – Cause the potential for loss, isolation, or alteration of an archaeological resource eligible for NRHP listing.
- Historic Resources – Cause the potential for loss, isolation, or alteration of the character of a historic site or structure eligible for NRHP listing. Introduce visual, audible, or atmospheric elements that would adversely affect a historic resource eligible for NRHP listing.
- Native American Resources – Cause the potential for loss, isolation, or alteration of Native American resources, including graves, remains, and funerary objects. Introduce visual, audible, or atmospheric elements that would adversely affect the resource's use.
- Other Cultural Resources
  - Paleontological Resources – Cause the potential for loss, isolation, or alteration of a paleontological resource eligible for listing as a National Natural Landmark (NNL).
  - Cemeteries – Cause the potential for loss, isolation, or alteration of a cemetery.

The Alliance conducted archival research to determine whether cultural resources are known to exist or may exist within the APE/ROI. This research was conducted at the THC, Texas Archaeological Research Laboratory (TARL), Texas General Land Office (GLO); and in the THC's Texas Archaeological Sites Atlas Database (THC, 2006) and the National Park Service (NPS) National Register Information System (NPS, 2006a) database. The Alliance also reviewed of existing literature and publications pertaining to previous cultural resource studies in the region (FG Alliance, 2006c; Miller and Yost, 2006).

To identify the potential for TCPs, the Alliance used the NPS Native American Consultation Database (NPS, 2006b; ***Miller and Yost, 2006***). This study also incorporated background research and pedestrian reconnaissance survey results of the proposed power plant site conducted by Miller and Yost (2006). No survey in association with the proposed FutureGen Project was conducted within the ROI for related areas of new construction or land above the sequestration reservoir.

The Alliance conducted archival research at the University of Texas, Austin, Vertebrate Paleontology Laboratory and in the NPS NNL database to determine the potential for significant paleontological specimens within the ROI (NPS, 2004). The Alliance also interviewed Dr. Ernest Lundelius, retired director of the Vertebrate Paleontology Laboratory.

Paleontological resources are generally geological in nature rather than cultural, but several environmental regulations have been interpreted to include fossils as cultural resources. The Antiquities Act of 1906 refers to historic or prehistoric ruins or any objects of antiquity situated on lands owned or controlled by the U.S. Government, but the term "objects of antiquity" has been interpreted by the NPS, Bureau of Land Management (BLM), U.S. Forest Service (USFS), and other federal agencies to include fossils. An area rich in important fossil specimens can potentially be a NNL as defined in the NPS's National Registry of Natural Landmarks (NRNL) (36 CFR 62.2). Paleontological resources are not analyzed under NHPA Section 106 unless they are recovered within culturally related contexts (e.g., fossils included within human burial contexts, a mammoth kill site).

6.10.2 AFFECTED ENVIRONMENT

6.10.2.1 Archaeological Resources

Power Plant Site

Records maintained by the THC and TARL, and found in the Texas Archaeological Sites Atlas Database (THC, 2006), show that nearly the entire proposed power plant site and its ROI have been assessed as part of archaeological surveys associated with the Jewett Mine and the NRG Limestone Electric Generating Station. A pedestrian reconnaissance survey of the proposed power plant site was conducted by Miller and Yost (2006). The goal of that investigation was to assess current conditions on the proposed power plant site and the condition of previously recorded archaeological sites.

Fifty-seven archaeological or historical sites have been recorded in the proposed power plant site ROI, including 22 prehistoric sites, 28 historic sites, and 7 sites with both prehistoric and historic components (FG Alliance, 2006c). The prehistoric sites and components consist of open campsites and lithic scatters. Historic sites and components consist of homesteads, farmsteads, and mining sites. The NRHP and SAL status of these sites is undetermined.

Site 41LN95, the Evansville Mine, was recorded within the proposed power plant site as a historic lignite mine with evidence of collapsed pits and mine shafts, a railroad spur, cinder heaps, and brick and concrete structures. The site appears to have been destroyed by lignite mining (Miller and Yost, 2006).

Sites 41LN94 and 41FT88 were recorded within the ROI in close proximity to the proposed plant site. Site 41LN94 was a small log shack cleared by bulldozing. Site 41FT88 was the Walker Log Crib, a single pen log crib of hewn, split, and squared logs. Miller and Yost (2006) did not make observations regarding the condition of Site 41FT88, but there is a high likelihood that it has been destroyed by lignite mining (FG Alliance, 2006c).

Given that nearly the entire ROI for the proposed power plant site has been surveyed, and strip mining and land reclamation has extensively disturbed the entire property, including destruction of Sites 41LN94 and 41LN95, there appears to be an extremely low potential for the existence of intact, unrecorded prehistoric or historic sites within the proposed plant site.

Sequestration Site

Only a small percentage of the land above the sequestration reservoir has been previously surveyed. A total of 33 archaeological sites, mainly dating from the prehistoric period, have been recorded within the ROI for this area (see Table 6.10-1). Until injection well locations and other areas of ground disturbance in the proposed sequestration site are defined, it is not known if any of the archaeological sites would be directly impacted by the FutureGen Project.

Utility Corridors

Water Supply Pipeline

Records maintained by the THC and TARL, and found in the Texas Archaeological Sites Atlas Database (THC, 2006), show that the entire water supply pipeline corridor has been assessed as part of archaeological surveys associated with the Jewett Mine and the NRG Limestone Electric Generating Station.

Thirty-eight previously recorded archaeological sites are within the ROI for the water supply corridor, including 19 prehistoric sites, 15 historic sites, and four sites with both prehistoric and historic components. These numbers include sites within the proposed power plant ROI. The NRHP and SAL status of these sites is undetermined. The prehistoric sites and components consist of open campsites and lithic scatters. Historic sites and components consist of homesteads, farmsteads, and mining sites. Site 41LT130 is within the boundaries of the proposed construction corridor. The site is recorded as a prehistoric open campsite.

Given that nearly the entire ROI has been previously surveyed and the area is likely to be extensively disturbed from strip mining and land reclamation, there appears to be an extremely low potential for the existence of intact, unrecorded prehistoric or historic sites within the water supply ROI.

CO_2 Pipeline

A review for the six proposed CO_2 pipeline segments was conducted in records of the THC and TARL, and the Texas Archaeological Sites Atlas Database (THC, 2006). No field survey has been conducted in association with the proposed FutureGen Project undertaking. Table 6.10-1 summarizes the findings of the record review for the CO_2 pipeline segments and land above the proposed sequestration reservoir.

Approximately 75 percent of Segment A-C has been previously surveyed. A total of 141 archaeological sites have been recorded within this segment's ROI (see Table 6.10-1), three of which are within the proposed pipeline corridor. Site 41FT118 is a prehistoric site situated on a hilltop consisting of a crevice lined with hematite boulders, Site 41FT129 is the historic Taylor homestead, and Site 41FT390 is a multi-component prehistoric campsite and historic homestead. The NRHP/SAL status of these sites is undetermined and additional work was recommended at Site 41FT118.

Table 6.10-1. Summary of Previous Archaeological Investigations in CO_2 Pipeline Segments and Sequestration Sites

Segment	Previously Surveyed	Archaeological Sites	
A-C	Approximately 75 percent	Prehistoric	76
		Historic	45
		Multi-Component	18
		Unknown	2
		Total	141
B-C	Approximately 30 percent	Prehistoric	118
		Historic	45
		Multi-Component	20
		Unknown	1
		Total	184
C-D	Unspecified small percentage	Prehistoric	41
		Historic	12
		Multi-Component	5
		Unknown	3
		Total	61
D-F	Unspecified small percentage	Prehistoric	7
		Historic	1
		Multi-Component	-
		Unknown	1
		Total	9
F-G	Unspecified small percentage	Prehistoric	5
		Historic	1
		Multi-Component	-
		Unknown	-
		Total	6
F-H	Unspecified small percentage	Prehistoric	9
		Historic	1
		Multi-Component	3
		Unknown	12
		Total	25
Land above sequestration reservoir	Unspecified small percentage	Prehistoric	26
		Historic	1
		Multi-Component	2
		Unknown	4
		Total	33

Source: FG Alliance, 2006c.

Approximately 30 percent of Segment B-C has been previously surveyed. A total of 184 archaeological sites have been recorded within this segment's ROI (see Table 6.10-1), 15 of which are within the proposed pipeline corridor. Site 41LN3 is a prehistoric village that may contain burials. Sites 41LN39, 41LN40, 41FT75, 41FT383, and 41FT384 are prehistoric campsites. Sites 41FT81, 41FT335, and 41FT336 are prehistoric lithic scatters. Sites 41FT82 and 41FT334 are prehistoric campsites with associated lithic scatters. Sites 41LN53 and 41FT74 are historic homesteads. Site 41LN52 is the Evansville/Miller Cemetery. No site form was available for Site 41FT491. Site 41FT334 is potentially eligible for NRHP listing, and the NRHP/SAL status of the remaining sites is undetermined.

Only a small percentage of Segment C-D has been previously surveyed. A total of 61 archaeological sites have been recorded within the ROI for this segment (see Table 6.10-1), 13 of which are within the proposed pipeline corridor. Sites 41FT62, 41FT73, 41FT75, 41FT82, 41FT374, 41FT383, and 41FT384 are prehistoric open campsites; Sites 41FT81 and 41FT380 are prehistoric lithic scatters; and Site 41FT33 is a prehistoric lithic procurement area. Site 41FT74 is a historic homestead. No site forms were available for Sites 41FT491 and 41FT493. Site 41FT33 is potentially eligible for NRHP listing in the NRHP, and the NRHP/SAL status of the remaining sites is undetermined.

Only a small percentage of Segment D-F has been previously surveyed. Nine archaeological sites have been recorded within the ROI for this segment (see Table 6.10-1). Site 41FT494 is mapped within the proposed pipeline corridor. The site form for that archaeological site is unavailable.

Only a small percentage of Segment F-G has been previously surveyed. Six archaeological sites have been recorded within the ROI for this segment (see Table 6.10-1), none of which are within the proposed pipeline corridor.

Only a small percentage of Segment F-H has been previously surveyed. A total of 25 archaeological sites have been recorded within the ROI for this segment (see Table 6.10-1), three of which are within the proposed pipeline corridor. Sites 41FT18 and 41FT495 are prehistoric open campsites and Site 41FT19 is a prehistoric shell midden. The NRHP/SAL status for these sites is undetermined.

6.10.2.2 Historic Resources

There are no documented historic properties listed in or potentially eligible for listing in the NRHP or SAL within the ROI for the proposed power plant site, related areas of new construction (including the water supply line corridor and the six proposed CO_2 corridors) or land above the proposed sequestration reservoir. However, there are four historical markers within the land above the proposed sequestration reservoir: the Harmony Baptist Church; the Jemison Quarters Cemetery; the Butler Soldiers' Home, C.S.A.; and the Mount Zion Methodist Church and Cemetery.

6.10.2.3 Native American Resources

No publicly documented TCPs are known to exist within the ROI for the proposed power plant site, related areas of new construction, or on the sequestration site. Consultation with federally recognized Native American tribes that may have an interest in the project area was initiated by letter on December 6, 2006 (see Appendix A). The following tribes received the consultation letter:

- The Caddo Nation of Oklahoma
- The Comanche Tribe of Oklahoma
- The Kiowa Tribe of Oklahoma
- The Tonkawa Tribe of Oklahoma
- The Wichita Tribe of Oklahoma
- The Alabama-Coushatta Tribe of Louisiana

Regional Directors for the Bureau of Indian Affairs in the Southern Plains Region also received a copy of the consultation letter. The Bureau of Indian Affairs Eastern Oklahoma Regional Office and the Southern Plains Regional Office both responded that they do not have jurisdiction over the alternative sites in Texas (see Appendix A). To date, one Native American tribe has responded to the consultation letter. The Alabama-Coushatta Tribe of Louisiana stated that they do not wish to continue receiving information on the project (see Appendix A).

6.10.2.4 Other Cultural Resources

Cemeteries

The presence of cemeteries within the project ROIs was determined through an examination of USGS topographic quadrangles, records maintained by the THC and TARL, and the Texas Archaeological Sites Atlas Database (THC, 2006).

Power Plant Site

Two formal cemeteries (the Wilson Chapel Cemetery [Site 41FT91] and the Evansville/Miller Cemetery [Site 41LN52]) and a third location (a historic homestead [Site 41LT143]) believed to contain two isolated graves are documented within the ROI of the proposed power plant. During Site 41LT143 documentation, local informants indicated that two ornamental bottles positioned on a fence-line near the homestead denoted the location of two graves associated with members of a family with the surname Connelly. None of these cemeteries are located within nor immediately adjacent to the boundaries of the proposed power plant site.

Sequestration Site

At least 11 formal cemeteries have been identified within the ROI for the proposed sequestration reservoir. The cemetaries include: Jimmison (or Jemison) Quarters, Tyus (Site 41FT285), Sand Hill, Maze, Pine Creek, Mount Zion, Antioch Church, Shiloh Church, Willis, Brooke, and Plum Creek. Until injection well locations and other areas of ground disturbance in the sequestration site are defined, it is not known if there would be potential for impact to these cemeteries.

Related Areas of New Construction – Water Supply Pipeline Corridor

Site 41LT143, a historic homestead that may contain two graves, is within the ROI of the water supply corridor. However, the site is neither within nor immediately adjacent to the proposed corridor boundaries.

Related Areas of New Construction – CO_2 Pipeline Corridor

There are four formal cemeteries within the ROI for Segment A-C: the Wilson Chapel Cemetery (Site 41FT91), the Old Spring Seat Church and Cemetery (Site 41FT85), the Post Oak Cemetery (Site 41FT120), and the Old Zion Cemetery (Site 41FT360). None of these cemeteries are located within or immediately adjacent to the proposed corridor boundaries for this segment.

There are four formal cemeteries within the ROI for Segment B-C: Jackson Cemetery, Sardis Church Cemetery, the Wilson Chapel Cemetery (Site 41FT91), and the Old Spring Seat Church and Cemetery (Site 41FT85). The Wilson Chapel Cemetery is within the proposed corridor boundary for this segment, and the remaining three cemeteries are outside of the corridor boundaries.

The Holly Grove Cemetery is located within the ROI of this segment, but is not located within the proposed corridor boundary.

The Shiloh Church Cemetery is located within the ROI of this segment, but is not located within the proposed corridor boundary.

The Tyus (Site 41FT285) and Sand Hill Cemeteries are formal cemeteries located within the ROI for this segment. Neither cemetery is located within the proposed corridor boundary.

Paleontological Resources

Paleontological resource investigations into the faunal prehistory of the region surrounding the proposed power plant site have been less productive of vertebrate remains than have many other parts of the state. The ROI for all aspects of the proposed FutureGen Project are situated at the very northwestern fringe of the Gulf Coastal Plains region (UTA, 1996). The Bureau of Economic Geology shows a transition from Mesozoic era deposits to Cenozoic era deposits some 25 miles (40.2 kilometers) west of the undertaking (***Miller and Yost, 2006***). Cretaceous period deposits from the transition between those the Mesozoic and Cenozoic have been lucrative to faunal specimen recovery. However, the ROIs are located in an Eocene epoch depositional band that is younger than Cretaceous deposits and traditionally unproductive of paleontological resources.

The likelihood of paleontological specimens existing within the ROI for the proposed FutureGen Project is low. A review of the NPS's NNL program indicated no recorded NNL properties within the ROI for this undertaking (NPS, 2004).

6.10.3 IMPACTS

6.10.3.1 Construction Impacts

Construction impacts to known or unknown cultural resources would primarily be direct and result in earth-moving activities that could destroy of some or all of a resource. As with any land-disturbing project, the potential for discovery or disturbance of unknown cultural resources exists, particularly in areas with no prior land disturbance. Although consultation with Native American tribes has not revealed the presence of TCPs in areas where disturbance could take place, this consultation is ongoing (see Appendix A) and the presence of these resources remains somewhat uncertain. However, before construction, previously unsurveyed areas with a potential for the presence of cultural resources would be surveyed. Potential impacts to cultural resources discovered during construction would be mitigated through avoidance or through other measures described in Table 3-14, including those identified through consultation with the THC or the respective Native American tribes.

Because ROIs for the proposed power plant site, sequestration site, and utility corridors are located in an area with relatively low potential for fossil specimens, there are no anticipated impacts to paleontological resources during construction.

Power Plant Site

The entire proposed power plant site and nearly the entire ROI for the plant site have been subject to cultural resource investigations. Miller and Yost (2006) found no historic archaeological sites, standing structures, or cemeteries within the ROI. In a letter dated August 28, 2006, from Horizon to the THC, a recommendation was made regarding the proposed power plant site that "a formal cultural resource survey of the proposed plant site is unwarranted" (FG Alliance, 2006c). The THC concurred with that recommendation with a concurrence line signature on that letter (FG Alliance, 2006c) (see Appendix A). Therefore, no direct or indirect impacts are anticipated from construction of the proposed power plant to cultural resources listed in or eligible for listing in the NRHP or SAL.

Sequestration Site

A small portion of the proposed sequestration site has been subject to cultural resource investigations and 33 archaeological sites, mainly prehistoric, have been recorded. Prehistoric archaeological sites in the region are typically located along major waterways and drainages. The presence of the Trinity River and numerous creeks, drainages, and lakes within the ROI suggests a high potential for additional unrecorded prehistoric archaeological sites in the ROI. The region has also been settled by Euro-Americans since at least the 1800s, and cemeteries and structures are shown on USGS topographic maps. Therefore, there is potential for direct impacts from construction at the proposed sequestration site to unrecorded archaeological and historical resources, including prehistoric or historic archaeological sites, standing structures, or cemeteries. In a letter dated October 5, 2006 (FG Alliance, 2006c), Horizon requested consultation and comments from the THC on cultural resource findings within the proposed sequestration site. In a letter dated October 31, 2006 (FG Alliance, 2006c), the THC concurred that archaeological survey of the sequestration site was needed (see Appendix A). Potential impacts would be mitigated through avoidance or through other measures, including those identified through further consultation with the THC.

Utility Corridors

In a letter dated October 5, 2006 (FG Alliance, 2006c), Horizon requested consultation and comments from the THC on the findings regarding cultural resources within areas of new construction that included the water supply pipeline and the CO_2 pipeline corridors. In a letter dated October 31, 2006 (FG Alliance 2006c), the THC concurred with recommendations, specifically that CO_2 pipeline segments C-D, D-F, F-G, and F-H would require surveys. CO_2 pipeline segments A-C and B-C, as well as the water pipeline corridor, would not require cultural resources surveys (see Appendix A).

Water Supply Pipeline

The proposed water supply corridor has been subject to cultural resources investigations that were associated with mining projects. Subsequent mining operations have likely destroyed any archaeological or historical sites in the area, including Site 41LT130, which was recorded within the proposed pipeline corridor. Therefore, there are no anticipated direct or indirect impacts from construction of the water supply pipeline to cultural resources listed in or eligible for listing in the NRHP or SAL.

CO_2 Pipeline

Portions of all proposed pipeline corridor segments were subjected to previous surveys that identified potential archaeological sites for which NRHP/SAL status has not been determined. Field assessments would be necessary to determine whether these sites have been affected by mining activity. Numerous creeks and drainage ways are present in the ROI for pipeline segments, and there is a long history of settlement by Euro Americans in the area. Hence, there is a moderate to high potential within the ROIs for additional unrecorded prehistoric and historic sites for which NRHP/SAL status has not been determined. Potential resources may be subject to impacts from construction that would be mitigated through avoidance or through other measures, including those identified through coordination with the THC. ROIs for seven corridor segments also include known cemeteries as listed below.

Approximately 75 percent of Segment A-C was previously surveyed. One hundred forty-one archaeological sites have been recorded within the ROI for this segment, three of which are within the proposed pipeline corridor. Four formal cemeteries are within the ROI for Segment A-C, but none are located within or immediately adjacent to the proposed corridor boundaries, and no construction impacts are anticipated.

Approximately 30 percent of Segment B-C was previously surveyed. One-hundred eighty-four archaeological sites have been recorded within the ROI for this segment, 15 of which are within the proposed pipeline corridor. Four formal cemeteries are within the ROI for Segment B-C, one of which is located within the proposed corridor boundaries and could be impacted by construction.

Approximately 30 percent of Segment C-D was previously surveyed. Sixty-one archaeological sites have been recorded within the ROI for this segment, 13 of which are within the proposed pipeline corridor. One formal cemetery is within the ROI for Segment C-D, but it is not located within or immediately adjacent to the proposed corridor boundaries, and no construction impacts are anticipated.

Only a small portion of the corridor for Segment D-F was previously surveyed. Nine archaeological sites have been recorded within the ROI for this segment, one of which is within the proposed pipeline corridor. One formal cemetery is within the ROI for Segment D-F, but it is outside the proposed corridor boundaries, and no construction impacts are anticipated.

Only a small portion of the corridor for Segment F-G was previously surveyed. Six archaeological sites have been recorded within the ROI for this segment, none of which are within the proposed pipeline corridor. Two formal cemeteries are within the ROI for Segment F-G; however, both are outside the proposed corridor boundaries, and no construction impacts are anticipated.

Only a small portion of the corridor for Segment F-H was previously surveyed. Twenty-five archaeological sites have been recorded within the ROI for this segment, three of which are within the proposed pipeline corridor. One formal cemetery is within the ROI for Segment F-H, but it is outside the proposed corridor boundaries, and no construction impacts are anticipated.

Transportation Corridors

The existing transportation infrastructure is adequate for the demands of the proposed FutureGen Project, and there are currently no plans to upgrade existing roads or railways or construct new ones. Therefore, there are no anticipated direct or indirect impacts associated with transportation infrastructure to cultural resources listed or eligible for listing in the NRHP or SAL.

6.10.3.2 Operational Impacts

The potential for impacts to cultural resources related to the proposed FutureGen Project operations would be limited to indirect impacts that could alter the historic character of a resource or its setting. There is minimal potential for direct impacts (e.g., a historic façade becoming coated with dust or ash) as a result of operations. Because there are no known cultural resources in areas where the proposed FutureGen Project operations would take place, no direct or indirect impacts are anticipated.

6.11 LAND USE

6.11.1 INTRODUCTION

This section identifies land uses that may be affected by the construction and operation of the proposed FutureGen Project at the Jewett Power Plant Site, sequestration site, and related corridors. It addresses the existing land use environment as well as potential effects on land uses and land ownership, relevant local and regional land use plans and zoning, airspace, public access and recreation sites, identified contaminated sites, and prime farmland. It also addresses potential effects related to subsurface rights for the proposed sequestration site.

6.11.1.1 Region of Influence

The ROI for land use includes the area within 1 mile (1.6 kilometers) of the boundaries of the proposed Jewett Power Plant Site, sequestration site, and all related areas of new construction, including proposed utility corridors.

6.11.1.2 Method of Analysis

DOE reviewed information provided in the Jewett EIV (FG Alliance, 2006c) and other relevant land use data, including the TPWD website, Federal Aviation Administration (FAA) regulations, and various databases related to contaminated sites. DOE also reviewed aerial photographs and made site visits to note site-specific land use characteristics. There are no comprehensive land use plans or zoning ordinances that apply to the proposed power plant site, sequestration site, or utility corridors.

DOE assessed the potential impacts based on whether the proposed FutureGen Project would:

- Introduce structures and uses that are incompatible with land uses on adjacent and nearby properties;
- Introduce structures or operations that require restrictions on current land uses on or adjacent to a proposed site;
- Conflict with a jurisdictional zoning ordinance; and
- Conflict with a local or regional land use plan or policy.

6.11.2 AFFECTED ENVIRONMENT

The proposed Jewett Power Plant Site consists of a contiguous 400-acre (162-hectare) parcel of land located in east-central Texas near the town of Jewett in the counties of Freestone, Limestone, and Leon. It is situated approximately 115 miles (185 kilometers) north of Houston, 105 miles (169 kilometers) south of Dallas, and 125 miles (201 kilometers) east of Austin. The cities of Corsicana, Waco, Huntsville and Bryan/College Station are located within a 75-mile (121-kilometer) radius of the site. Centerville, the county seat of Leon County, is 18 miles (29 kilometers) southeast of Jewett. The proposed power plant site is located in a generally rural area. No major surface water bodies are located on the proposed Jewett Power Plant Site or within its ROI. The closest significant water body is Lake Limestone, located approximately 3 miles (5 kilometers) west of the site.

The 400-acre (162-hectare) parcel that would house the power plant and associated facilities lies within a larger 3,000-acre (1,214-hectare) tract of land that is currently permitted and operating as a lignite coal mine. The existing Jewett Mine has been operated by Texas Westmoreland Coal Company (TWCC) for many years and provides lignite to the 1,700-megawatt (MW) NRG Limestone Electric

Generating Station mine-mouth power plant, which is located 0.5 mile (0.8 kilometer) northwest of the proposed Jewett Power Plant Site along FM 39. Adjoining properties are used for purposes related to energy production, including the Limestone power plant's ash management operations, which are located immediately north of the proposed Jewett Power Plant Site on the north side of CR 795. Other activities in the area consist of gas production and a mini-mill steel mill.

The proposed Jewett Sequestration Site is located in a rural area of Freestone and Anderson counties, approximately 33 miles (53 kilometers) northeast of the proposed Jewett Power Plant Site. The land area above the proposed sequestration reservoir is minimally developed both for surface or subsurface uses (ranch land, gas development, and agriculture). There are at least six small communities located on the land area above the proposed sequestration reservoir, including Plum Creek, Red Lake, Butler, Sand Hill, Massey Lake, and Harmony. The general area contains improved and unimproved roads, transmission lines, oil and gas pipelines, quarries, gravel pits, and borrow pits. The northeastern-most part of the proposed sequestration site is located within the TDCJ's prison farm system.

6.11.2.1 Local and Regional Land Use Plans

DOE identified no local or regional land use plans affecting the proposed Jewett Power Plant Site, sequestration site, or utility corridors. Limestone, Freestone, and Anderson counties have subdivision and roadway design and construction requirements that may need to be complied with, depending on final project design and specifics of land acquisition or division.

6.11.2.2 Zoning

There are no local zoning districts or development standards in effect in the area of the proposed Jewett Power Plant Site, sequestration site, or utility corridors.

6.11.2.3 Airspace

Two public airport facilities are located within a 25-mile (40-kilometer) radius of the proposed Jewett Power Plant Site. The closest public airport is the Teague Municipal Airport, located on FM 80 (also known as Airport Road) in Teague, Texas, approximately 16 miles (26 kilometers) from the proposed power plant site. The second closest airport is the Mexia-Limestone County Airport, located approximately 22 miles (35 kilometers) from the proposed power plant site in Mexia, Texas. The nearest airport to the sequestration site or any of the utility corridors is the Palestine Municipal Airport, located in the town of Palestine approximately 12 miles (19 kilometers) east of the northernmost sequestration area and CO_2 corridor segment F-H.

Because the proposed project would include a 250-foot (76-meter) heat recovery steam generator (HRSG) stack and 250-foot (76-meter) flare stack, DOE reviewed FAA regulations to determine their applicability to the project. In administering 14 CFR Part 77—Objects Affecting Navigable Airspace—the prime objectives of the FAA are to promote air safety and the efficient use of the navigable airspace. Pursuant to 14 CFR Part 77, the FAA must be notified if any of the following construction or alteration is being examined:

(1) Any construction or alteration of more than 200 feet (61 meters) in height above the ground level at its site.
(2) Any construction or alteration of greater height than an imaginary surface extending outward and upward at one of the following slopes:

(i) 100 to 1 for a horizontal distance of 20,000 feet (6,096 meters) from the nearest point of the nearest runway of each airport specified in paragraph (a)(5) of this section with at least one runway more than 3,200 feet (975 meters) in actual length, excluding heliports.
(ii) 50 to 1 for a horizontal distance of 10,000 feet (3,048 meters) from the nearest point of the nearest runway of each airport specified in paragraph (a)(5) of this section with its longest runway no more than 3,200 feet (975 meters) in actual length, excluding heliports (14 CFR Part 77).

6.11.2.4 Public Access Areas and Recreation

According to the TPWD website, there are no recreational areas within the proposed power plant site or its associated ROI (TPWD, 2006). The closest recreation area is Lake Limestone, located approximately 3 miles (5 kilometers) west of the site.

DOE personnel observed one recreational area within the proposed sequestration site. This is a roadside picnic area along westbound U.S. Highway 84, approximately 2 miles (3.2 kilometers) east of its intersection with FM 489. This highway pull-off rest stop has two canopied picnic tables and trash cans. There are no other facilities (e.g., restrooms) at this picnic area.

6.11.2.5 Contaminated Sites

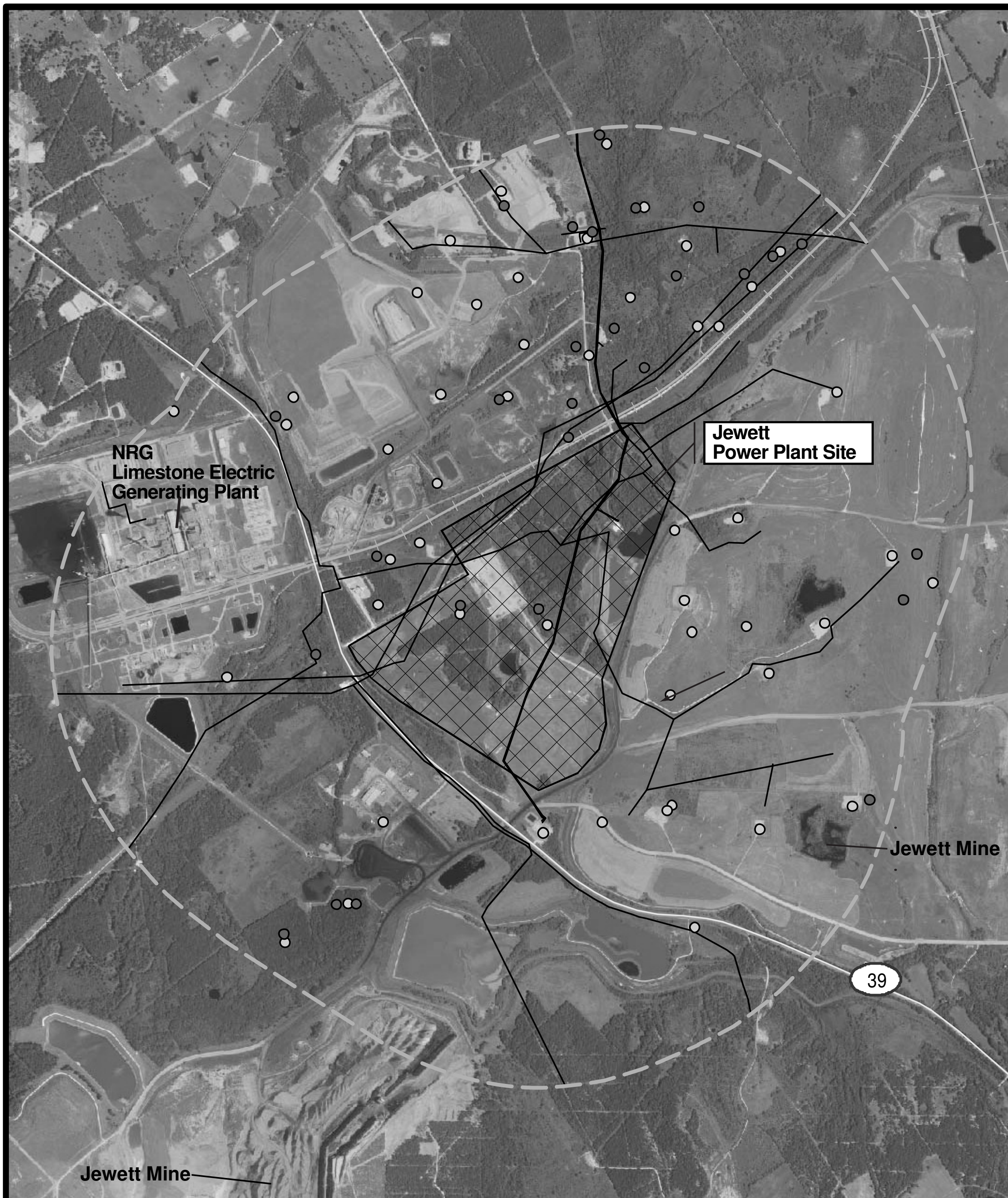
Horizon Environmental Services, Inc., performed a Phase I Environmental Site Assessment (ESA) on the proposed Jewett Power Plant Site in April 2006 (Horizon Environmental Services, 2006). The site assessment indicates that metal storage sheds, diesel storage tanks, 55-gallon (208-liter) drums, waste/debris piles, tank trucks, chemical storage areas, storage areas for farm implements, and pipeline easements occur on the subject site in the area known as Site 2. During the site assessment, field personnel observed signs indicating surface spillage of petroleum-related substances, resulting in stained soils. According to the Phase I ESA, however, any resulting contamination was not determined to be significant with respect to siting another industrial facility on the site. The ESA recommended further soil testing before site construction to determine if any soil contamination might exceed the Texas Commission on Environmental Quality (TCEQ) Risk Reduction Standard for industrial sites (Horizon Environmental Services, 2006).

Based on a reporting of TCEQ information, there is no documented evidence of contaminated groundwater within 1 mile (1.6 kilometers) of the proposed Jewett Power Plant Site (FG Alliance, 2006c). If the Jewett site is selected for the FutureGen Project, groundwater samples would need to be taken and analyzed for hydrocarbons before construction to determine whether any contamination related to past operations at the site exists.

6.11.2.6 Land Ownership and Uses

Power Plant Site

The proposed Jewett Power Plant Site consists of mostly open land. The site and the general area around the site are located in a rural area where land use has been dominated historically by ranching, gas well activities, and lignite mining activities (Horizon Environmental Services, 2006). The proposed site is located southeast of the existing NRG Limestone Electric Generating Station and contains unimproved roads and structures related to gas well activities. The site also has electric utilities. General land use on the site and within its ROI is shown in the aerial photograph in Figure 6.11-1.



U.S. Department of Energy
FutureGen Project EIS
Data Source: FutureGen Alliance, 2006c
USDA FSA APFO 2004;
RCT 2005, BEG 2006

Legend

- Jewett Power Plant Site
- Water Wells
- Oil/Gas Wells
- Existing Oil/Gas Pipelines
- 1-Mile ROI
- Railroad

All land within the ROI is owned by NRG or Texas Westmorleand Coal Company

Figure 6.11-1
Aerial Photo of the Proposed Jewett Power Plant Land Use ROI

0 0.25 0.5 MI
0 0.25 0.5 KM
N

The property within the proposed Jewett Power Plant Site is currently held by NRG Texas and TWCC. All of the lands within the 1-mile (1.6-kilometer) ROI are also owned by NRG Texas or TWCC, and many of these parcels are leased by or otherwise have surface or subsurface rights with various other individuals.

Historical aerial photographs of the proposed power plant site, dated 1939, 1964, 1989, 1995, and 2004, indicate that the site consisted of grazing land and post oak woodland that changed very little from 1939 to 1964. Beginning in the 1980s, lignite surface mining activities began at the TWCC's Jewett Surface Lignite Mine (Jewett Mine) and continue to the present. The southern part of the proposed Jewett Power Plant Site consists of land that was previously surface-mined, and has since been reclaimed and stabilized in accordance with State of Texas (Railroad Commission of Texas, or RCT) post-mine reclamation regulations (Trouart, 2006). This part of the site is currently used as pasture land and for hay production. Much of the northern part of the site has not been mined and is currently wooded, primarily with deciduous trees (e.g., oak, willow) and scrub pine. The central part of the site includes an approximately 21-acre (8.5-hectare) white rock pad area, noted above as Site 2. This area currently is used as a contractor staging area, storage for mining and haybaling equipment, pipe-fusing area, and other general outdoor storage (Trouart, 2006). Two natural gas wells are located on the proposed power plant site, and one new gas well was being constructed near Site 2 at the time of DOE's November 2006 site visit.

In addition to the two gas wells on the proposed power plant site (and one under construction), RCT records indicate that a minimum of 35 gas wells are located within the ROI. Nine gas-gathering lines and one gas transmission line traverse the ROI at various locations. One of the lines at the northern end of the ROI is a sour gas (i.e., poison gas) line. At least 12 other gas pipelines traverse the ROI. Four of these pipelines traverse the proposed Jewett Power Plant Site (FG Alliance, 2006c). TWDB records reveal 23 documented water wells within the ROI (FG Alliance, 2006c). Two of these water wells are present within the boundaries of the proposed power plant site.

In addition to the NRG Limestone Electric Generating Station and the active TWCC Jewett Mine, which is located south of the proposed Jewett Power Plant Site, other notable land uses in the plant ROI include the NRG Limestone Electric Generating Station's ash management operations, which are located immediately north of the site on the north side of CR 795. These operations include ash handling facilities, a treatment plant, ash landfill, and other associated facilities. Much of the other adjacent land outside of the active plant area of the Jewett Mine has been reclaimed or is in the process of being reclaimed to prior uses in accordance with State of Texas regulations (Trouart, 2006).

No residences, churches, libraries, schools, prisons, nursing homes, hospitals, recreational areas, or historic areas are located within the ROI of the proposed Jewett Power Plant Site. One cemetery, the Wilson Chapel and Cemetery, is located along CR 795, just north of the proposed power plant site. This cemetery also has a building used for burial services, but no church services are held at this facility (Trouart, 2006).

Sequestration Site

The proposed sequestration site is located in rural areas of Freestone and Anderson counties, where land use has been dominated historically by ranching, farming, and oil and gas activities. The area is located on both sides of U.S. Highway 84, with the majority of the area situated north of the highway. Two of the three proposed injection sites are located on the Hill Ranch in Freestone County near the Trinity River, which divides Freestone and Anderson counties. The other proposed injection site is located on the north (or east) side of the Trinity River in Anderson County on land owned by the Texas

Department of Criminal Justice. The 22,000-acre (8,903-hectare) Department of Criminal Justice property includes five prison units, but a majority of the property is undeveloped. The general land area above the proposed sequestration reservoir appears to have experienced little commercial growth with the exception of cattle ranching and the cultivation of crops, as well as natural gas activities. The majority of the area consists of range and crop land with a low population density.

The Jewett EIV reports a minimum of 322 permitted or developed natural gas and oil wells existing within the land area above the proposed sequestration reservoir (FG Alliance, 2006c). A minimum of 21 natural gas pipeline systems, two crude oil pipeline systems, and one liquefied petroleum gas pipeline system exists within or cross the area. TWDB records indicate a minimum of 146 documented water wells occurring within the area (FG Alliance, 2006c). The actual number of wells may be somewhat lower than stated because the southernmost sequestration reservoir area (located generally south of the communities of Red Lake and Butler), which was included initially in project planning efforts, has since been withdrawn from the proposal by the site proponents (FG Alliance, 2006c).

The towns or communities of Harmony, Sand Hill, Red Lake, and Butler are located within the land area above the proposed sequestration reservoir. Butler has the area of highest population (67 residents), while Harmony has 12 residents (FG Alliance, 2006c). No populations were noted for the communities of Sand Hill or Red Lake in the 2000 federal Census data; however, DOE personnel observed a number of residences and farms along FM 489 and FM 360 in the community of Red Lake during the November 2006 site visit.

The Jewett EIV (FG Alliance, 2006c) reports that topographic maps show approximately 704 undifferentiated residential and commercial structures existing within the land area above the proposed Jewett Sequestration Reservoir (FG Alliance, 2006c). Thirteen churches, seven cemeteries, three schools, and one correctional facility (the previously mentioned prison farm) are shown within the area. No libraries, nursing homes, hospitals, or historic areas were shown to exist in the area. DOE personnel observed one recreational area (a roadside picnic area) during the November 2006 site visit along U.S. Highway 84 (see Section 6.11.2.5). In addition, DOE personnel observed two recreational areas (Red Lake Fishing & Hunting Club and Lake Burleson Fishing Club) along FM 360 near the community of Red Lake during the November 2006 site visit.

An offer has been made for a 50-year lease on the Jewett Sequestration Site, with 100 percent surface access and a waiver of mineral and water rights for at least three injection sites totaling approximately 1,550 acres (627 hectares) in two locations: approximately 1,125 acres (455 hectares) at one location and approximately 425 acres (172 hectares) at a second location (FG Alliance, 2006c). However, the status of this offer is uncertain, and complete title searches for subsurface rights at the injection sites, proposed Jewett Sequestration Reservoir, and a 0.25-mile (0.4-kilometer) buffer, including questions of who owns the rights to the reservoir and what those specific rights are, have not been researched for inclusion in this EIS. Entities with potential property rights include the land surface owners (e.g., the Hill Ranch and the State of Texas), mineral and resource interest owners, royalty owners, and reversionary interest owners (that is, owners of an interest in a reservoir that becomes effective at a specified time in the future [de Figueiredo et al., 2005]). Mineral and resource rights are discussed in further detail in Section 6.4.

Utility Corridors

Process Water Pipeline Corridor

The Alliance would obtain process water by installing wells on site or within less than 1 mile (1.6 kilometers) of the site. If needed, the process water supply pipeline from off-site wells would be located south of the existing NRG Limestone Electric Generating Station and a pipeline less than 1 mile

(1.6 kilometers) long would be constructed. The corridor contains unimproved roads and structures related to gas well activities. The corridor crosses FM 39, a north-to-south running county road that is the primary access for the Jewett Mine, NRG Limestone Electric Generating Station, and proposed Jewett Power Plant Site. The ROI appears to have experienced little commercial growth with the exception of surface lignite mining activities beginning in the 1980s. The process water line itself, as currently conceived, would cross from west to east, immediately north of the current entrance to the Jewett Mine and office. The majority of the ROI consists of range and crop land with a low population density. The ROI is located in an area of moderate gas well development.

The Jewett EIV (FG Alliance, 2006c) includes a summary comparison of the existing land uses within the proposed water supply corridor and ROI, including undifferentiated structures, pipelines, permitted or developed gas and oil wells, water wells, sensitive receptors, and major road crossings, as presented in Table 6.11-1. The summary is based on a review of topographic maps (FG Alliance, 2006c) and DOE site observations.

Table 6.11-1. Comparison of Land Uses Within the Potential Utility Corridors and their ROIs.

Corridor	Total Length (miles [kilometers])	Structures	Gas/Oil Pipelines	Gas/Oil Wells	Water Wells	Sensitive Receptors[1]	Major Roads[2]
Process Water Pipeline							
	<1 (<1.6)	40	9	28	13	0	1
CO_2 Pipeline							
Segment A-C	8 (12.9)	56	12	103	35	6	1
Segment B-C	14.5 (23.3)	63	11	85	16	6	1
Segment C-D	15 (24.1)	130	11	48	17	2	4
Segment D-F	9 (14.5)	45	11	25	13	1	1
Segment F-G	6 (9.7)	30	6	24	7	2	0
Segment F-H	14 (22.5)	30	8	28	4	1	0

[1] Sensitive Receptors = cemeteries, churches, libraries, schools, prisons, nursing homes, hospitals, recreation areas, or historic areas.
[2] Major Roads = State or County Roads.
Source: Compiled from FG Alliance, 2006c.

CO_2 Pipeline Corridor

All six segments of the proposed CO_2 pipeline corridor traverse very similar land uses and terrain. All are located in rural areas where land use has been and continues to be dominated by ranching, gas well activities, cropland, and in the southern parts of the ROI near the Jewett Mine, surface lignite mining. Almost all include crossings of unimproved roads and structures related to gas well activities or ranching. Most corridors and ROIs appear to have experienced little commercial growth. Other than the small communities identified previously, the area within the ROI has a low population density. Table 6.11-1 describes a summary comparison of the additional land uses within the proposed CO_2 pipeline corridor and ROI, including undifferentiated structures, pipelines, permitted or developed gas and oil wells, water wells, sensitive receptors, and major road crossings.

As shown in Table 6.11-1, most of the CO_2 pipeline segment ROIs contain a number of undifferentiated structures, gas or oil pipelines, permitted or developed gas or oil wells (primarily gas), water wells, and sensitive receptors. Of the two possible southern segments (A-C and B-C) (refer to Figures 2-10 and 2-11), B-C is approximately 6.5 miles (10.5 kilometers) longer, but contains fewer potential land use conflicts within the corridor, particularly gas and water wells. Segments A-C and B-C have the highest number of gas or oil wells within their ROIs of any of the segments, and the segment A-C has the highest number of water wells. Topographic maps indicate that there are generally more undifferentiated residential and commercial structures located within segment C-D than the other segments, while segments A-C and B-C have more sensitive non-residential/commercial receptors than the other segments. Four cemeteries and two churches also exist within the segment A-C and B-C corridor ROIs. Each of the other segments has at least one cemetery within its ROI, and segment C-D contains a recreational area.

The only nearby area of relatively high population density in the southern segment corridors is the town of Jewett, located 2.5 miles (4.0 kilometers) and 7 miles (11 kilometers) southeast of the B-C and A-C segment corridor ROIs, respectively. Jewett has a population of approximately 861 individuals (FG Alliance, 2006c). The nearby areas of comparatively high population density near the segment C-D corridor ROI are the towns of Buffalo and Dew, located 2 miles (3 kilometers) east and 4 miles (6 kilometers) northwest of the ROI, respectively. Buffalo has a population of approximately 1,804 and Dew has a population of approximately 71 (FG Alliance, 2006c). The northernmost part of the proposed CO_2 pipeline corridor (segment F-H, located north of the Trinity River in Anderson County) traverses the previously mentioned prison farm. Much of this land north of the Trinity River consists of ranch and cattle grazing lands with some wooded areas. A few small gas and oil operations are also located in this area. The most notable land use within the segment F-H corridor ROI is the prison farm itself. The entire property upon which the prison and the northeastern-most proposed injection site is located incorporates 22,000 acres (8,903 hectares), and features five individual prison units and associated facilities for approximately 15,000 inmates (Karriker, 2006).

6.11.2.7 Prime Farmland

The Gasil fine sandy loam is considered prime or unique farmland soil within the proposed Jewett Power Plant Site in Leon and Freestone ***counties*** (NRCS, 2006). This soil type makes up only a small portion of the site. None of the soil types in Limestone County are considered prime or unique soil types (NRCS, 2006). Gasil, Padina, and Silstid fine sandy loams are considered prime farmland soils found within the proposed water supply pipeline corridor. Gasil, Rader, Silawa, and Oakwood fine sandy loams are considered prime farmland soils found within four of the six proposed CO_2 pipeline corridor segments (i.e., A-C, B-C, C-D, and F-G).

> The U.S. Department of Agriculture (**USDA**) Natural Resource Conservation Service's (**NRCS**) website defines prime farmland as land that has the best combination of physical characteristics for producing food, feed, forage, and oilseed crops and is available for these uses (NRCS, 2000).

6.11.3 IMPACTS

6.11.3.1 Construction Impacts

Power Plant Site

Construction of the FutureGen Project at the proposed Jewett Power Plant Site would have little notable impact on existing land use on the site or within the 1-mile (1.6-kilometer) ROI of the site. The project would require a laydown area for construction equipment and materials and would require construction of a power plant, rail loop, parking area, coal storage site, visitor center, and research and development center. Project construction would have a long-term impact on the current uses of pasture land, gas activities, and a storage/maintenance area associated with the adjacent TWCC Jewett Mine, which would need to be relocated on another part of the mine property. The use of at least two active gas wells and a new well on the project site could be lost or the wells relocated, depending on final design and layout of the facility. Project construction would have no impacts on any residents or sensitive receptors in the area. Only minor impacts to the TWCC mine and associated ash management operations located along FM 39 and CR 795 (possible temporary access delays during construction) could potentially occur. However, depending on final design and location of construction laydown areas, land use itself on these properties should not be affected.

As noted previously, the Phase I ESA (Horizon Environmental Services, 2006) recommended further soil testing before site construction to determine if any soil contamination might exceed the TCEQ Risk Reduction Standard for industrial sites. If evidence of a leak or spill is identified in soils during construction, project construction would cease while the area is assessed to determine the extent of contamination and to minimize potential health impacts to construction workers. Any such investigations and subsequent remediation, if necessary, would be performed in accordance with appropriate federal and state of Texas regulations.

Land use at the one cemetery located within the ROI (Wilson Chapel and Cemetery) would not be affected by construction of the plant at the proposed Jewett Power Plant Site. In addition, because the proposed site is well outside the 20,000-foot (6,096-meter) radius within which FAA Part 77 Airspace Obstruction Analysis is required, and because there is no military restricted use airspace in the vicinity of the proposed site, construction of the power plant would have no effect on airspace.

Sequestration Site

Construction at the Jewett Sequestration Site would have little direct or indirect impact in terms of the overall land use in the vicinity. Construction at the sequestration site would remove up to 10 acres (4 hectares) of land from a ranch or from the Texas Department of Criminal Justice depending upon the alternative chosen. Areas surrounding the injection wells and equipment would be available for future ranching or other uses. In addition, some areas of land would be lost temporarily to the construction of access roads needed to reach the injection sites. Together, fewer than 10 acres (4 hectares) would be required for wells and access. Construction schedules and requirements would be coordinated closely with the Texas Department of Criminal Justice and the Hill Ranch to minimize any potential temporary impacts on their operations. No other direct or indirect impacts to land uses, including land use plans, airspace, sensitive receptors, public access/recreation, or other uses are expected.

Utility Corridors

Construction at the proposed pipeline corridors would have temporary, minor effects on land use during the actual construction period due to trenching, equipment movement, and material laydown. The ability to use current lands for their existing uses (primarily cattle ranching and gas production) along each of the utility corridors would be temporarily lost during construction. This is particularly true for utilities requiring subsurface construction (i.e., water and CO_2 pipelines). CO_2 pipeline Segments A-C and F-G would likely have the largest area of temporary impact on existing land uses of any of the segments based solely on the amount of new ROW that would need to be constructed through otherwise undisturbed land; the remaining segments would generally follow existing ROW and would be expected to result in less temporary land use disturbance than the segments needing new ROW. For the two CO_2 pipeline segment options leading from the proposed power plant, Segment A-C, although shorter, would likely result in more disturbance than B-C because of the amount of new ROW needed.

The proposed Jewett Power Plant Site could connect to either a 345-kilovolt (kV) transmission line bordering the northwest boundary of the site with a new substation or a 138-kV line within about 2 miles

(3.2 kilometers) from the site (FG Alliance, 2006c). Construction to connect to the 138-kV line would result in temporary, minor effects on range land. After construction is complete, the range land would likely return to their current use.

Because of the open land, sparse population, and low number of structures located throughout all the corridors, DOE expects that the underground utilities could be routed in most places to avoid conflicts with any structures other than pipeline or road crossings. After construction is complete, the areas would be regraded and revegetated in accordance with conditions of any applicable permits, and most original land uses should be able to continue.

Transportation Corridors

Direct and indirect impacts from construction of the proposed transportation infrastructure would be similar to those for the power plant: a loss of some existing pasture land and range land, depending upon their locations. Leon County, in association with the TWCC, is scheduled to relocate a portion of FM 39, east of the proposed power plant site, farther to the north to allow TWCC to mine farther to the north (Trouart, 2006). This project is expected to start in 2008 and last for 1 year. Construction of any proposed project-related transportation infrastructure in this area south and east of the proposed Jewett Power Plant Site would be carefully coordinated with Leon County and TWCC to minimize any potential conflicts during construction.

As mentioned previously, Limestone, Freestone, and Anderson ***counties*** have subdivision and roadway design and construction requirements that may need to be complied with, depending on final project design and specifics of land acquisition or division. Construction of project-related transportation infrastructure requiring compliance with any regulations would be coordinated with the county governments as deemed necessary.

6.11.3.2 Operational Impacts

Power Plant Site

Construction and operation of the FutureGen Project at the proposed Jewett Power Plant Site would permanently convert up to 200 acres (81 hectares) of existing pasture land located on the site to an industrial use that would be generally unusable for other purposes. Up to 3 oil and gas production wells would be displaced or relocated. The remaining 200 acres (81 hectares) on the site could continue to be used for existing purposes. However, there would be little notable impact on existing land use in the immediate site vicinity or within the 1-mile (1.6-kilometer) ROI of the site. The proposed Jewett Power Plant would be compatible with the land uses near the plant site because the majority of the land within the ROI is used for industrial purposes (i.e., coal production, ash management, power production, and gas well activities). Other than these compatible operations, little other development is present within the ROI.

The use of the Wilson Cemetery located north of the site, rarely used in recent years (Trouart, 2006), would not be affected by the proposed power plant and could continue its minimal operations without impact. The proposed Jewett Power Plant Site is well outside the 20,000-foot (6,096-meter) radius within which FAA Part 77 Airspace Obstruction Analysis applies (FG Alliance, 2006c). There is no military restricted use airspace near the proposed power plant, sequestration reservoir, utility corridors, or areas of related construction. Project operation would, therefore, have no appreciable impact on the use of airspace. However, signal lights would be required atop the HRSG and flare stacks because FAA regulations require such lighting for any structure more than 200 feet (61 meters) tall (14 CFR Part 77).

Only a very small amount (less than 5 acres (2 hectares), if any) of prime or unique farmland soils (Gasil fine sandy loam) located on the site could potentially be affected.

Sequestration Site

Operation of the injection sites would be compatible with the overall land use in the vicinity. Small areas at the injection sites and access roads to the injection sites (less than 10 acres [4 hectares] overall) would be unavailable for future ranching or other uses. The Texas Administrative Code (Title 30, Chapter 331) and the State Water Code (Chapter 27) contain requirements relating to underground injection wells and controls. These regulations would need to be adhered to during project construction and operation. No other impacts to land uses, including land use plans, airspace, sensitive receptors, or public access/recreation would be expected. While some soils considered to be prime farmland are located within the lands above the sequestration reservoir, most of this land is currently used as ranchland, so little or no prime farmland and no agricultural use would be affected.

An offer has been made for a 50-year lease on the Jewett Sequestration Site lands with 100 percent surface access and a waiver of mineral and water rights for at least three injection sites totaling approximately 1,550 acres (626 hectares) in two locations (FG Alliance, 2006c). However, the status of this offer and any other conditions are uncertain at this time. Any applicable subsurface rights for minerals or oil and gas resources would still need to be acquired or otherwise negotiated.

Utility Corridors

Depending on the depth below grade of the underground utilities and the need to retain a cleared ROW, it is likely that most lands above the proposed utility corridors and related areas of construction could continue to be used for ranching, farming, or any passive uses. Any existing or future subsurface activities (e.g., gas drilling or mining) would not be possible in the immediate utility corridor once the utilities were installed. The use of potential prime farmland soils (i.e., Gasil, Rader, Silawa, Silstid, Padina, and Oakwood fine sandy loams found within the proposed water supply corridor ROI and four of the six proposed CO_2 pipeline corridors), if any, could potentially be lost to active farming. As discussed previously, however, the majority of lands within the CO_2 pipeline corridors are range land; therefore, minimal impacts to prime farmland soils would be expected.

If the new 2-mile (3.2-kilometer) transmission line is built, permanent loss of land would only occur at the pole locations.

Transportation Corridors

The proposed transportation infrastructure could result in the loss of a very small amount of ranch land and pasture land on the proposed Jewett Power Plant Site and in areas where access roads would be needed to reach the sequestration injection sites and utility ROW. The new transportation infrastructure to the power plant site (e.g., railroad spurs and access roads) would occur on the site itself, so additional offsite impacts would be minimal.

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6.12 AESTHETICS

6.12.1 INTRODUCTION

This section identifies viewsheds and scenic resources that may be affected by the construction and operation of the proposed FutureGen Project at the Jewett Power Plant Site, sequestration site, and related corridors. It addresses the appearance of project features from points where those features would be visible to the general public, and takes into account project characteristics such as light and glare. The distance from which the proposed power plant and associated facilities would be visible depends upon the height of the structures associated with the facilities, including buildings, towers, and electrical transmission lines, as well as upon the presence of existing intervening structures and local topography. Effects on visual resources can result from alterations to the landscape, especially near sensitive viewpoints, or an increase in light pollution.

6.12.1.1 Region of Influence

The ROIs for aesthetic resources include areas from which the proposed Jewett Power Plant Site and all related areas of new construction would be visible. The ROIs are defined as 10 miles (16.1 kilometers) surrounding the proposed power plant site, 1 mile (1.6 kilometers) around the proposed sequestration site and on either side of the proposed electrical transmission line corridor, and immediately adjacent to the proposed underground utility corridors.

6.12.1.2 Method of Analysis

DOE identified land uses and potential sensitive receptors in the ROIs of the proposed power plant site, sequestration site, and utility corridors based on site visits and a review of information included in the Jewett EIV (FG Alliance, 2006c). The EIV includes analyses of 1964 and 1982 topographic maps as well as recent aerial photography. DOE used two approaches to assess the potential impacts of the proposed FutureGen Project on aesthetic resources. First, DOE applied Geographic Information Systems (GIS)-based terrain modeling, combined with height information associated with the proposed project facilities (i.e., the 250-foot [76-meter] HRSG stack and 250-foot [76-meter] flare stack), to determine the distance from which the facilities could be seen if there were no intervening structures or vegetation to screen the view. Secondly, DOE considered two artistic concepts of the proposed FutureGen Power Plant to depict a range of aesthetic approaches to the project. One concept is of a typical power plant with minimal screening and architectural design, while the second concept includes extensive screening and architectural design. DOE compared and contrasted the two concepts to assess the relative level of visual intrusiveness for each concept.

DOE assessed the potential for impacts based on whether the proposed FutureGen Project would:

- Affect a national, state, or local park or recreation area;
- Degrade or diminish a federal, state, or local scenic resource;
- Create visual intrusions or visual contrasts affecting the quality of a landscape; and
- Cause a change in a BLM Visual Resource Management classification.

6.12.2 AFFECTED ENVIRONMENT

6.12.2.1 Landscape Character

Natural and human-created features that give the landscape its character include topographic features, vegetation, and existing structures. The topography of the ROI consists of undulating hills with elevations ranging from 420 to 500 feet (128.0 to 152.4 meters) above mean sea level. The highest elevation of the proposed Jewett Power Plant Site is located on the northeastern side, while the lower elevations are located along Red Hollow Creek on the southeastern side.

Prior to mining activities, the vegetation around the proposed Jewett Power Plant Site consisted of oak woodlands and pasture land. Today, the vegetation at the site is primarily post-mine reclamation grasses. A more detailed description of the vegetation of the proposed Jewett Power Plant Site is provided in Section 6.9.

The proposed Jewett Power Plant Site and surrounding environs are situated in a rural area characterized by ranching, gas well activity, and surface lignite mining. Unimproved roads and structures related to gas well activities are located on the site. Existing industrial structures, including the NRG Limestone Electric Generating Station less than 0.5 mile (0.8 kilometer) west of the site (Figure 6.12-1) and overhead electric utilities lines, have already affected the character of the surrounding landscape.

Additionally, mining activities continue approximately 2 miles (3.2 kilometers) to the northeast and less than 1 mile (1.6 kilometers) to the southwest of the proposed Jewett Power Plant Site. Consequently, previous disturbances have altered the natural characteristics of the landscape.

Figure 6.12-1. Proposed Jewett Power Plant Site with NRG Limestone Electric Generating Station in the Background

Structures within the ROI for the Jewett Power Plant Site include the NRG Limestone Electric Generating Station facilities, roadways, a railroad, cemeteries, and a church. As previously mentioned, the presence of the stacks and other tall buildings associated with the NRG Limestone Electric Generating Station within the ROI has already altered character of the natural landscape. Several local roadways are situated within the ROI, including FM 39, CR 795, and numerous other improved roads associated with the NRG Limestone Electric Generating Station, mining activities, and well pads. The Burlington Northern Santa Fe Railroad line runs along the east side of the ROI, and a spur of the railroad runs along the northern side of the proposed Jewett Power Plant Site. Based on aerial photography, no modern residential structures appear to be located within the ROI for visual effects.

No BLM or USFS Visual Resources Management classifications or designated scenic vistas are located within the visual resources ROI (***FG Alliance,*** 2006***c***). According to the TPWD website, there are no recreational areas within the proposed Jewett Power Plant Site or its associated ROI (TPWD, 2006).

The proposed Jewett Sequestration Site is located in a rural area where land use has been dominated historically by ranching, farming, and oil and gas activities. The area is located on both sides of US 84, with most of the area situated south of US 84. Pending final design and land agreements, this land may extend further north into Anderson County to encompass considerable land currently owned by the TDCJ (see Figure 6.12-2). The area appears to have experienced little commercial growth with the exception of cattle ranching and the cultivation of crops, as well as natural gas activities. The majority of the area consists of range and crop land with a low population density, although eight small communities or towns are located on the land area above the proposed sequestration reservoir (FG Alliance, 2006c).

Figure 6.12-2. Proposed Jewett Sequestration Site

The related areas of new construction associated with the proposed Jewett Power Plant Site include a proposed water supply pipeline corridor and seven segments of the proposed CO_2 pipeline corridor. The proposed 52- to 59-mile (83.7- to 95.0-kilometer) long CO_2 pipeline corridor passes through undulating hills in primarily undeveloped areas dominated by rolling hills and post oak woodland vegetation. Developments include improved and unimproved roads, transmission lines, pipelines, gravel pits, drill holes, and oil and gas development. The ROI of segment F-H also includes a landing strip, an athletic field, a sewage disposal facility, and a pumping station (FG Alliance, 2006c).

6.12.2.2 Light Pollution Regulations

Light pollution is defined as the night sky glow cast by the scattering of artificial light in the atmosphere. According to the online database of Texas laws and regulations maintained by Texas Legislation Online (TLO), Texas has three state codes referencing light pollution (TLO, 2006):

- In 2001, Local Government Code Chapter 240, Subchapter B, authorized counties to regulate outdoor lighting in the vicinity of the George Observatory near Houston, Stephen F. Austin University at Nacogdoches, and within a 57-mile (91.7-kilometer) radius of the McDonald Observatory in southwest Texas.
- In 1999, Health and Safety Code Subtitle F, Light Pollution, Chapter 425, stated that all new or replacement state-funded outdoor lighting must be from cutoff luminaries if the rated output of the fixtures is greater than 1,800 lumens.
- In 1995, Transportation Code Chapter 315, Subchapter A, authorized municipalities to regulate artificial lighting and outlined their responsibilities. This did not include unincorporated areas in counties.

These state codes do not apply to the area within the proposed Jewett Power Plant Site or associated ROI. Additionally, within the tri-county (Freestone, Limestone, and Leon) area, there are no local ordinances, plans, or goals for light pollution abatement (Wilkinson, 2006).

6.12.3 IMPACTS

6.12.3.1 Construction Impacts

Power Plant Site

During construction at the proposed Jewett Power Plant Site, only workers at the nearby mine and power plant would have an unobstructed view of the construction site and equipment moving on and off the site during the 44-month construction period. Construction would not be visible to the general public.

Given the scale of past mining and oil extraction activities in the area, it is unlikely that any historic structures in the Jewett Power Plant Site ROI are preserved enough to be protected. Furthermore, the presence of the NRG Limestone Electric Generating Station and its associated facilities has already altered the viewshed of these structures.

Sequestration Site

Construction at the proposed Jewett Sequestration Site would not be visible to the general public.

Utility Corridors

During construction along the proposed water supply and CO_2 pipeline corridors, equipment used for trenching, pipe laying, and other construction activities would be visible only to viewers immediately adjacent to the pipeline corridors and construction laydown areas. This would constitute a direct short-term impact on those nearest the corridors during the construction period, which would vary depending upon the number of construction crews and the selected corridor. A single crew laying 1 mile (1.6 kilometers) of pipeline per week (FG Alliance, 2006c) would complete CO_2 pipeline construction in 25 to 45 weeks and water supply pipeline construction in about one week.

Transportation Corridors

Once construction is complete, the transportation corridors would appear similar to other transportation infrastructure already in place and would not cause an additional visual impact.

6.12.3.2 Operational Impacts

Power Plant Site

Major equipment for the power plant would include the gasifier and turbines, a 250-foot (76-meter) tall HRSG stack, a 250-foot (76-meter) tall flare stack, synthesis gas cleanup facilities, coal conveyance and storage systems, and particulate filtration systems. Additionally, the project would include on-site infrastructure, such as a rail loop for coal delivery, plant roads and parking areas, administration buildings, ash handling and storage facilities, water and wastewater treatment systems, and electrical transmission lines, towers, and a substation.

Once construction is complete, the tallest structures associated with the proposed Jewett Power Plant Site would include the main building, stacks, and communications towers. The maximum proposed height of the facility is 250 feet (76 meters). DOE's terrain analysis indicates that the facility would be visible from a distance of 7 to 8 miles (11.3 to 12.9 kilometers). The proposed FutureGen Power Plant would have aesthetic characteristics similar to other industrial facilities in the immediate area, such as the NRG Limestone Electric Generating Station.

For those viewing the power plant from the adjacent roads or nearby industrial facilities or from a greater distance, the appearance of the facilities would depend upon the degree of architectural development and visual mitigation included in the design. Figures 6.12-3 and 6.12-4 show two points on a range of conceptual IGCC plant designs. Figure 6.12-3 is an artist's rendering of an IGCC facility proposed for Orlando, Florida (DOE, 2006a). This rendering shows a plant with minimal screening or enclosure of the facility components. Figure 6.12-4 is the artist's conceptual design of the proposed FutureGen Power Plant that was used during the scoping process for this EIS (DOE, 2006b). This rendering shows a plant with a high degree of architectural design, including enclosure of most of the plant features.

The proposed facility is still in the design stage, and decisions have not yet been made about the final configuration or appearance of the power plant. A plant design similar to Figure 6.12-3 would create a more industrial appearance, similar to the existing NRG Limestone Electric Generating Station. Although still very large in scale, a plant design similar to Figure 6.12-4 would have a less industrial appearance, and would be visually less intrusive than the plant design shown in Figure 6.12-3.

Regardless of the final appearance of the proposed power plant, plant lighting and the flare would be highly visible at night. The facility, including the vapor plumes, would likely be visible for a comparable distance. Intervening buildings, vegetation, and topography would reduce the visibility of the plant from some vantage points. The lights would likely be visible for approximately 7 to 8 miles (11.3 to 12.9 kilometers) or more at night.

Because there are no BLM visual resource management classifications or designated scenic vistas in the power plant site, sequestration site, or transmission line ROIs, the project would not have any effect on those classifications. Additionally, because there are no light pollution standards applicable in the area, the plant would create no conflict with such standards. Nonetheless, the choice of appropriate outdoor lighting and the use of various design mitigation measures (e.g., luminaries with controlled candela distributions, well-shielded or hooded lighting, directional lighting) could reduce the effects of nighttime glare associated with plant lighting.

Sequestration Site

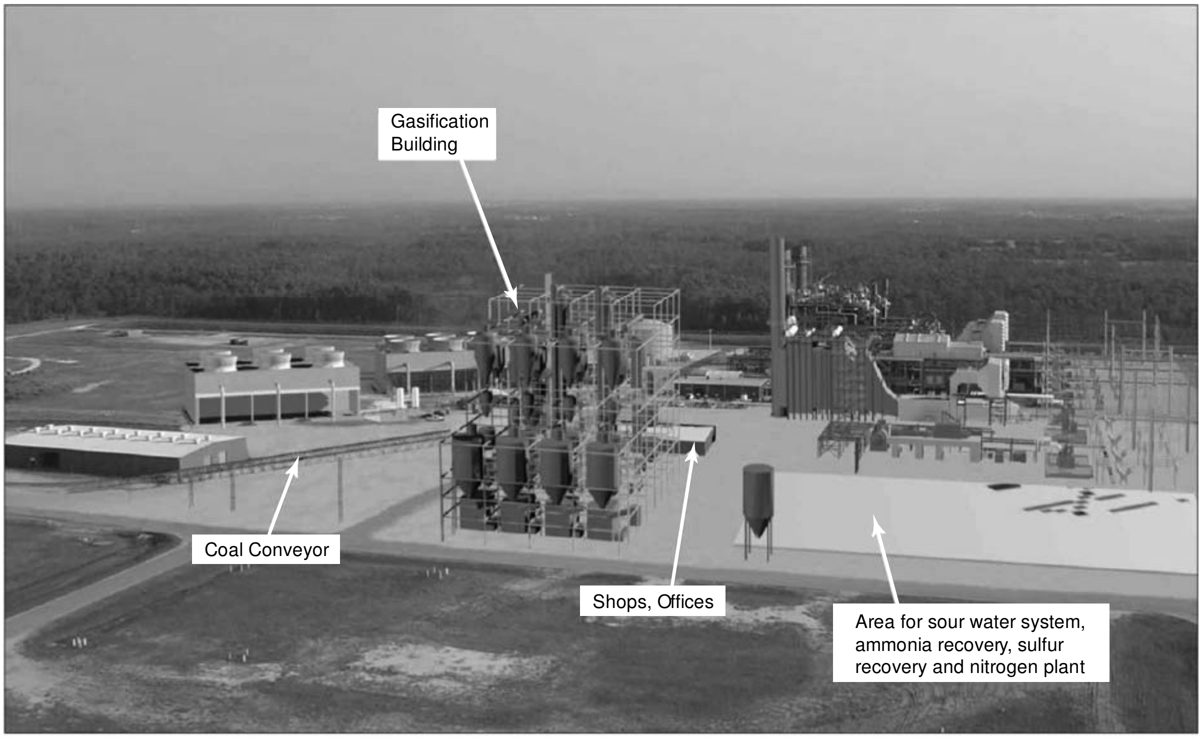
Once construction is complete, the tallest structures associated with the proposed Jewett Sequestration Site would be about 10 feet (3.0 meters) tall. Some wellheads would be visible to those passing by on the adjacent roads, but would not be visible from a distance. Thus, the project would create a direct, minor visual intrusion for those nearest the site.

Utility Corridors

Once construction is complete, the pipeline corridors would be revegetated and would have essentially the same appearance as before construction, except in areas where trees were removed. The pipeline corridor would be kept clear of trees for the life of the project. Pump stations or compressor stations that could be associated with proposed pipelines would be noticeable to those traveling on adjacent roads.

Transportation Corridors

Once construction is completed and the power plant is in operation, the visual impacts would be similar to those for the power plant site, sequestration site, and utility corridors.



Source: DOE, 2006a

Figure 6.12-3. Artist's Rendering of an IGCC Plant with Minimal Screening and Architectural Design Elements

Source: DOE, 2006

Figure 6.12-4. Artist's Rendering of an IGCC Plant with Extensive Screening and Architectural Design Elements

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6.13 TRANSPORTATION AND TRAFFIC

6.13.1 INTRODUCTION

This section discusses the roadway and railroad networks that may be affected by the construction and operation of the proposed FutureGen Project at the Jewett Power Plant Site.

6.13.1.1 Region of Influence

The ROI for the proposed Jewett Power Plant Site includes roadways within a 50-mile (80.5-kilometer) radius of the boundaries of the site (see Figure 6.13-1). The site is located just northwest of the town of Jewett. The proposed Jewett Site is bordered by FM 39 and can be accessed via US 79, and is 12 miles (19.3 kilometers) from I-45. Because most vehicle trips to the site would primarily be via FM 39, the analysis focuses on FM 39 and its connecting roads: I-45; US 79 and 84; and SH 164. The Burlington Northern Santa Fe railway line runs along the northeastern border of the proposed power plant site.

6.13.1.2 Method of Analysis

DOE reviewed information provided in the Jewett EIV (FG Alliance, 2006c), which characterizes elements in the roadway hierarchy within the ROI based on function (e.g., city street and rural arterial), traffic levels, and observed physical condition. The EIV also includes traffic data obtained from the Texas Department of Transportation (TxDOT). The number of vehicle trips generated during construction and operations was based on data provided in the Jewett EIV (FG Alliance, 2006c).

> **LOS** is a qualitative measure that describes operational conditions within a traffic stream, generally in terms of service measures as speed, travel time, freedom to maneuver, traffic interruptions, comfort, and convenience (TRB, 2000).

Traffic impacts were assessed using the planning methods outlined in the Transportation Research Board's "2000 Highway Capacity Manual" (2000 HCM) (TRB, 2000), which assigns a level of service (LOS) to a particular traffic facility based on operational conditions within a traffic stream, generally in terms of service measures as speed, travel time, freedom to maneuver, traffic interruptions, comfort, and convenience (TRB, 2000); and The American Association of State Highway and Transportation Officials' (AASHTO) "A Policy on the Design of Highways and Streets" (the Green Book) (AASHTO, 2004), which describes LOS in more qualitative terms. The Green Book defers to the 2000 HCM to define LOS by facility type. The measures of effectiveness to assign LOS vary depending on the traffic facility. Highway Capacity Software Plus (HCS+) was used to perform capacity analysis.

For two-lane highways, the measure of effectiveness in assessing operations is the percent of time spent following another vehicle. LOS A through LOS F are assigned to a facility based on this measure of effectiveness. The LOS depends on the Highway Class (I or II), lane and shoulder widths, access-point density, grade and terrain, percent of heavy vehicles, and percent of no-passing zones within the analysis segment. Class I highways, according to the 2000 HCM, are highways where a motorist expects to travel at relatively high speeds. They are typically primary links in a state or national highway network and serve long-distance trips. A Class II highway typically operates at lower speeds and most often serves shorter trips. Class II also includes scenic or recreational routes. Table 6.13-1 defines each LOS category for Class I and II two-lane highways.

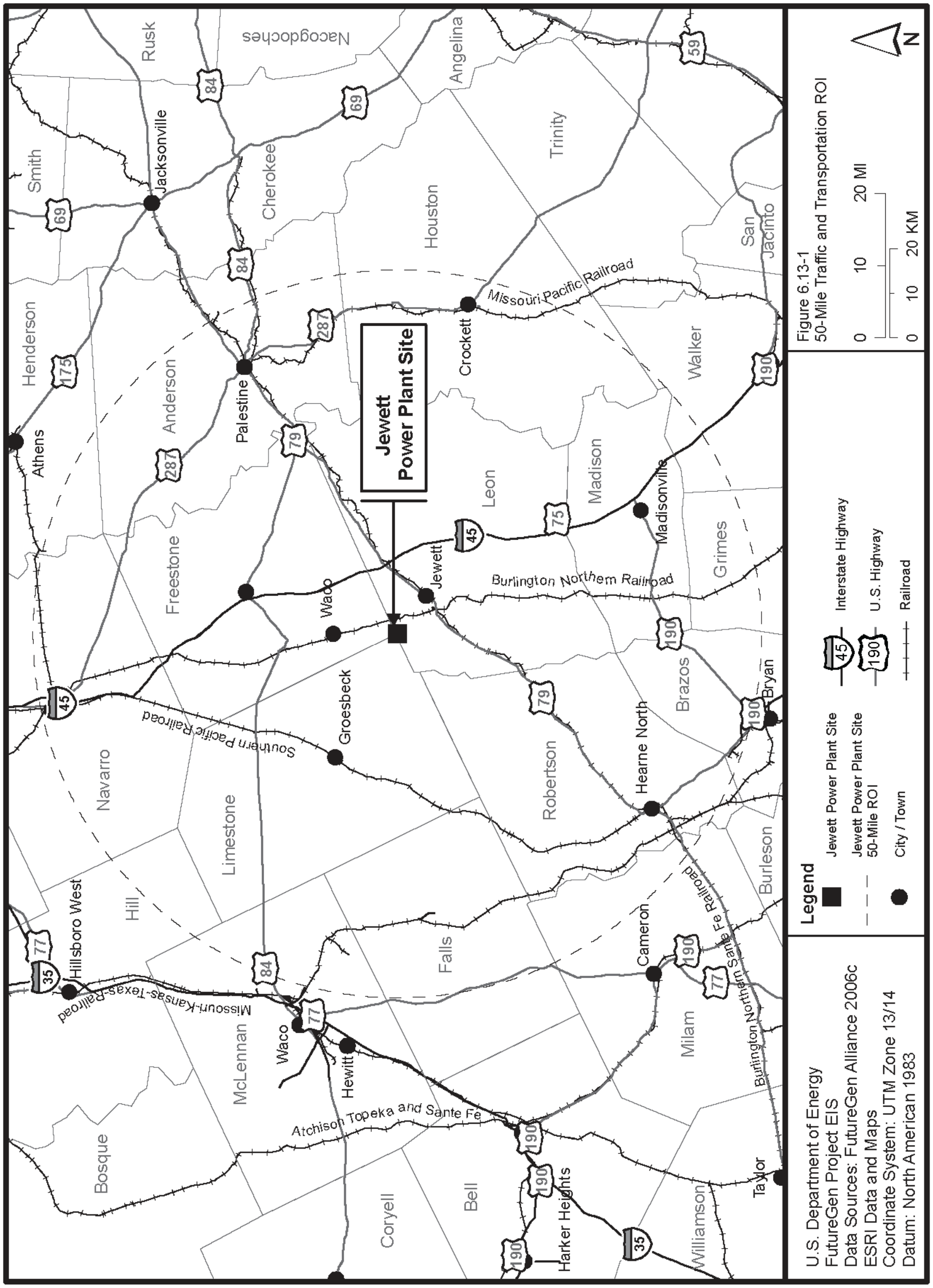


Figure 6.13-1
50-Mile Traffic and Transportation ROI

Table 6.13-1. Level of Service Criteria, Two-Lane Highways

LOS	Class I Two-Lane Highway		Class II Two-Lane Highway
	Percent Time Spent Following Another Vehicle	Average Travel Speed (mph [kmph])	Percent Time Spent Following Another Vehicle
A	< 35	>55 (88.5)	< 40
B	> 35 - 50	> 50 - 55 (80.5 – 88.5)	> 40 - 55
C	> 50 - 65	> 45 - 50 (72.4 – 80.5)	> 55 - 70
D	> 65 - 80	> 40 - 45 (64.4 – 72.4)	> 70 - 85
E	> 80	≤ 40 (64.4)	> 85

LOS F applies whenever the flow rate exceeds the capacity of the highway segment.
mph = miles per hour; kmph = kilometers per hour; LOS = Level of Service.
Source: TRB, 2000.

For multi-lane highways, the primary measure of effectiveness is density, measured in passenger cars per mile per lane. The traffic density is defined on the free-flow speed, ranging from 45 to 60 mph (72.4 to 96.6 kmph). The LOS depends on the lane width, lateral clearance, median type, number of access points, free-flow speed, and percent of heavy vehicles. Table 6.13-2 defines the LOS criteria for each free-flow speed on a multi-lane highway.

Table 6.13-2. Level of Service Criteria, Multi-Lane Highways

Free-Flow Speed (mph [kmph])	Criterion	LOS				
		A	B	C	D	E
60 (96.6)	Maximum density (pc/mi/ln)	11	18	26	35	40
55 (88.5)		11	18	26	35	41
50 (80.5)		11	18	26	35	43
45 (72.4)		11	18	26	35	45

LOS F is not included in the table; vehicle density is difficult to predict due to highly unstable and variable traffic flow.
mph = miles per hour; kmph = kilometers per hour; LOS = Level of Service.
Source: TRB, 2000.

For basic freeway segments, the measure of effectiveness is density, measured in passenger cars per mile per lane. The LOS depends on the lane width, lateral clearance, number of lanes, interchange density, free-flow speed, and percent of heavy vehicles. Table 6.13-3 defines the LOS criteria for each free-flow speed.

The Green Book describes LOS in qualitative terms as follows: LOS A represents free flow, LOS B represents reasonably free flow, LOS C represents stable flow, LOS D represents conditions approaching unstable flow, and LOS E represents unstable flow; and LOS F represents forced or breakdown flow (AASHTO, 2004).

Table 6.13-3. Level of Service Criteria, Basic Freeway Segments

LOS	Passenger Cars Per Mile Per Lane
A	0 – 11
B	>11 – 18
C	>18 – 26
D	>26 – 35
E	>35 – 45
F	>45

LOS = Level of Service.
Source: TRB, 2000.

No information is available for turning movements at specific intersections within the ROI. Therefore, intersection LOS has not been estimated for this analysis. However, DOE identified key intersection and evaluated the LOS qualitatively based on relative traffic volumes on intersecting roadways.

Though there are accident reduction factors that can be used to estimate a reduction in crashes based on a specific type of highway improvement, no methods are available for estimating the increase in crashes due to increased roadway volume. In addition, specific recent accident data for the roadways around the proposed Jewett Power Plant Site are not available. DOE qualitatively assessed potential safety impacts in this analysis.

DOE assessed the potential for impacts based on whether the proposed FutureGen Project would:

- Increase traffic volumes as to degrade LOS conditions on roadways;
- Alter traffic patterns or circulation movements;
- Alter road and intersection infrastructure;
- Conflict with local or regional transportation plans;
- Increase rail traffic compared to existing conditions on railways in the ROI; and
- Conflict with regional railway plans.

6.13.2 AFFECTED ENVIRONMENT

6.13.2.1 Roads and Highways

Access to the proposed Jewett Power Plant Site is primarily via FM 39, which intersects US 79 and SH 164 within 10 miles (16.1 kilometers) of the site boundary. The site is less than 15 miles (24.1 kilometers) from I-45. Figure 6.13-2 shows the regional highway network. The proposed Jewett Sequestration Sites are located about 33 miles (53.1 kilometers) northeast of the proposed Jewett Power Plant Site. Access to the proposed sequestration sites would be primarily via US 84.

TxDOT Highways/Roadways

FM 39 runs north and south, paralleling I-45 for approximately 90 miles (144.8 kilometers) between Dawson and Singleton. FM 39 has a weight capacity of 58,420 pounds (26,499 kilograms) (FG Alliance, 2006c) and provides one lane in each direction in the vicinity of the proposed Jewett Power Plant Site.

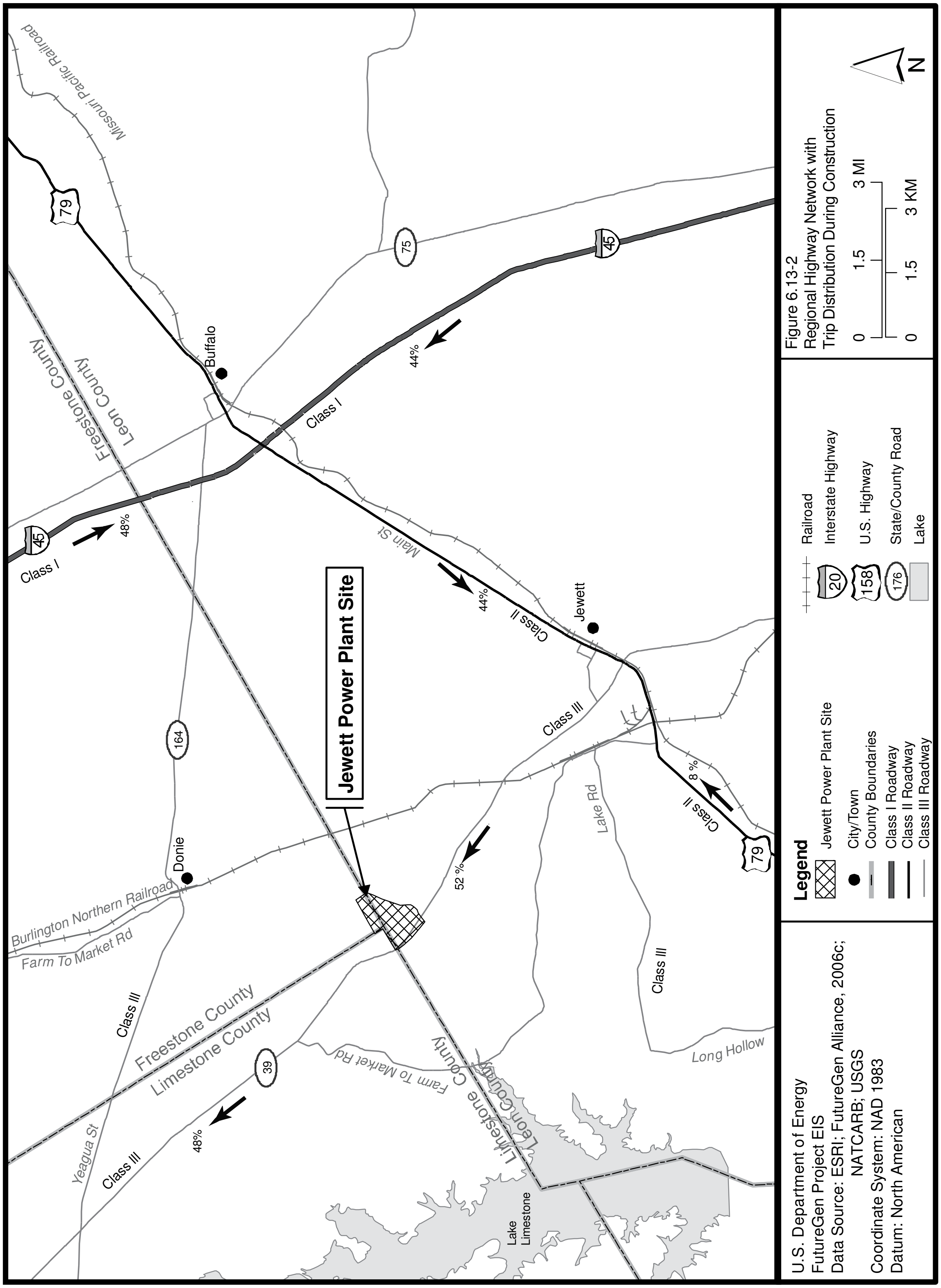


Figure 6.13-2
Regional Highway Network with Trip Distribution During Construction

US 79 runs northeast to southwest, facilitating transportation between Austin, Texas, and Louisiana. Vehicle loadings of up to 80,000 pounds (36,287 kilograms) may travel on US 79 without a permit. A vehicle that weighs 80,000 to 100,000 pounds (36,287 to 45,359 kilograms) may travel on US 79 with a permit (FG Alliance, 2006c). US 79 is a four-lane limited access highway in the vicinity of the proposed Jewett Power Plant Site.

The I-45 corridor directly connects Dallas to Houston and the Gulf Coast. In the vicinity of the proposed FutureGen Project, I-45 provides two lanes in each direction with a median. I-45 is rated to carry 80,000 pounds (36,287 kilograms) per vehicle, which is the state standard (FG Alliance, 2006c).

Traveling east and west is also possible via SH 164 or US 84. SH 164 is a two-lane highway in the vicinity of the proposed Jewett Power Plant Site. US 84 is a two-lane highway in the vicinity of the proposed Jewett Sequestration Site.

Key intersections in the vicinity of the proposed plant site include:

- FM 39 and US 79 (ramp termini)
- FM 39 and SH 80
- US 79 and I-45 Northbound ramps
- US 79 and I-45 Southbound ramps
- SH 164 and I-45 Northbound ramps
- SH 164 and I-45 Southbound ramps

The State of Texas does not have truck route designations for their highway or roadway network.

Programmed Transportation Improvements

Certain parts of the ROI would be affected or touched by the development of the proposed Trans-Texas Corridor (TTC). The TTC is a proposed multi-use, statewide network of transportation routes in Texas that would incorporate existing and new highways, railways, and utility ROWs. The TTC would also include separate lanes for passenger vehicles and large trucks, freight railways, and high-speed commuter railways, as well as infrastructure for utilities including water lines, oil and gas pipelines, and transmission lines for electricity, broadband, and other telecommunications services. TTC is projected to be completed in phases over the next 50 years. TxDOT will oversee planning, construction, and ongoing maintenance of the TTC (FG Alliance, 2006c).

TxDOT also anticipates widening or new location projects to begin in the next 10 years on roadways within the ROI (FG Alliance, 2006c). The following identifies the proposed projects and approximate distance from the proposed Jewett Power Plant Site:

- FM 2154 (Wellborn Road), widening from two to six lanes from FM 2818 to SH 40 (50 miles [80.5 kilometers]);
- SH 21, widening from two to four lanes from Kurten to the Navasota River (40 miles [64.4 kilometers]);
- SH 6 widening from two to four lanes from US 79 in Hearne to FM 1644 in Calvert (40 miles [64.4 kilometers]); and
- FM 60 (University Drive), widening from two to four lanes from SH 6 to FM 158 (48 miles [77.2 kilometers]).

The TWCC will relocate a section of FM 39 and the current train overpass to reclaimed land, to facilitate the continuation of mining operations at its Jewett Surface Lignite Mine (Jewett Mine). This relocation is scheduled to begin in 2007 and be completed in approximately one year (FG Alliance, 2006c).

6.13.2.2 Railroads

Class I – Gross annual operating revenues of $277.7 million or more

Class II – Non-Class I railroad operating 350 or more miles and with gross annual operating revenues between $40 million and $277.7 million

Class III – Gross annual operating revenues of less than $40 million

Texas ranks second nationally in the number of freight railroads (40) (TxDOT, 2005). The Surface Transportation Board categorizes rail carriers into three classes based upon annual earnings. The earnings limits for each class were set in 1991 and are adjusted annually for inflation.

The proposed Jewett Power Plant Site is located approximately halfway between two major Texas transportation centers – Dallas/Fort Worth and Houston/Galveston metropolitan areas. There are two Class I railroads in the ROI, the Union Pacific and the Burlington Northern Santa Fe (see Figure 6.13-1). The site lies 6.5 miles (10.5 kilometers) from the junction of these two major railroads. The Burlington Northern Santa Fe crosses through the area approximately 2 miles (3.2 kilometers) from the proposed Jewett Power Plant Site, with a railroad spur along the northern side of the proposed power plant site (FG Alliance, 2006c). The Burlington Northern Santa Fe rail line connects with coal fields in Wyoming, the Illinois Basin, Appalachia, and the west. The existing rail spur at the proposed Jewett Power Plant Site can be used for construction materials lay-down. This line has access to lines in Mexico, the West Coast, Midwest, Gulf Coast, and East Coast, that provide service to potential sources of fuel and materials for construction and operation.

Representatives from both the Union Pacific and the Burlington Northern Santa Fe provided the following information about the railroads they represent, unless otherwise specified. The rail lines within the ROI are used for freight, and passenger trains rarely, if ever, use this section of the railroad. The railways that pass through the ROI are designed with a maximum grade of 1 percent (FG Alliance, 2006c).

The weight capacity of the Burlington Northern Santa Fe track within the ROI is a maximum of 286,000 pounds (129,727 kilograms) gross weight (railcar plus lading) per carload. Including locomotives, the length of a Burlington Northern Santa Fe train is typically 7,400 feet (2,256 meters), with a gross loaded weight of approximately 19,100 tons (17,330 metric tons). Coal unit trains typically consist of three to four locomotive units trailed by 128 railcars. This north-south line passes near Jewett and is one of two primary Burlington Northern Santa Fe lines between the Dallas/Fort Worth and Houston/Galveston areas. The Burlington Northern Santa Fe currently serves two coal-burning power plants within the ROI. Wyoming Powder River Basin coal is shipped to these two existing power plants, with a combined weight of 4.5 million tons (4.1 million metric tons) of coal per year (FG Alliance, 2006c).

Union Pacific's track allows for a train speed of 40 mph (64.4 kmph). With access to the Powder River Basin in Wyoming and coal fields in Illinois, Colorado, and Utah, the Union Pacific moves more than 250 million tons (226.8 million metric tons) of coal per year. There are three main lines that run near the proposed Jewett Power Plant Site. The two north-south lines each have a gross weight capacity of car on rail set at 315,000 pounds (142,881 kilograms). The east-west line has a gross weight capacity of car on rail set at 286,000 pounds (129,727 kilograms) (FG Alliance, 2006c).

6.13.2.3 Local and Regional Traffic Levels and Patterns

Regional Traffic

In 2005, FM 39 had an average daily traffic (ADT) volume of 2,650 vehicles per day (vpd) (FG Alliance, 2006c). The 2005 ADT on US 79 was 7,500 vpd. I-45 had an ADT volume of 29,000 vehicles per day (vpd) in 2005 in the vicinity of the proposed Jewett Power Plant Site. These volumes as well as those on other routes are shown in Table 6.13-4.

Typically, morning and afternoon peak hour volumes range from 8 to 12 percent of the ADT (Table 6.13-4). Peak hour truck percentages are typically slightly lower than the daily truck percentage because truckers prefer to travel in off-peak hours. However, to be conservative, the existing daily truck percentages were maintained for this analysis.

Based on the existing roadway LOS reported in Table 6.13-4, DOE concluded that the key intersections near the proposed Jewett Power Plant Site are likely to be operating at LOS C or better as well.

Table 6.13-4. 2005 Average Daily and Peak Hour Traffic Volumes

Roadway	ADT[1] (vpd)	Truck ADT[2] (vpd)	Weekday Peak Hour Volume[3] (vph)	Weekday Peak Hour Truck Volume[2,3] (vph)	LOS[4]
FM 39	2,650	265	265	27	B
US 79	7,500	750	750	75	A
I-45	29,000	2,900	2,900	290	B
SH 164	2,740	274	274	27	B
US 84	6,500	650	650	65	C

[1] Source: FG Alliance, 2006c.
[2] No truck data were available. DOE assumed 10 percent trucks, which is consistent with surrounding roadways.
[3] DOE estimate of peak hour volume and LOS assumed peak hour equals 10 percent of ADT.
[4] DOE used HCS+ to perform capacity analysis.
ADT = average daily traffic; vpd = vehicles per day; vph = vehicles per hour; LOS = Level of Service.

Truck Traffic

The area surrounding the proposed Jewett Power Plant Site is an active lignite mine, so mining trucks could deliver lignite to the plant on dedicated coal haul roads if that coal source were used. I-45 lies 12 miles (19.3 kilometers) from the proposed site and intersects with US 79 and SH 164, which are both near the site, allowing for truck delivery of fuels or equipment.

No truck traffic volumes were available for the roadways surrounding the proposed Jewett Power Plant Site. DOE assumed that the existing volumes include 10 percent trucks. Based on this assumption, the 2005 truck ADT on FM 39 was 265 trucks per day. Based on the same assumption, approximately 750 trucks per day used US 79, and approximately 2,900 trucks per day used I-45.

Rail Traffic

The proposed Jewett Power Plant Site would be served by the Union Pacific and the Burlington Northern Santa Fe railroads. The Burlington Northern Santa Fe Railroad borders the site to the northeast (see Figure 5.13-2). No data were available regarding the exact number of trains that run by the Burlington Northern Santa Fe. Union Pacific currently runs 10 to 12 freight trains per day through the ROI (FG Alliance, 2006c). Walden (2006) assumed that Burlington Northern Santa Fe runs a similar number of trains (10 to 12 trains per day) near the proposed Jewett Power Plant Site.

In order to establish a new railroad grade crossing, a petition must be filed with the Interstate Commerce Commission (ICC) by either the railroad (or the track owner), the Local Roadway Authority, or TxDOT. It is ICC policy to require signals and gates (at a minimum) if permission is granted to install a new crossing. The petitioner is generally assessed all installation costs. If the new crossing is within 100 feet (30.5 meters) of a signalized crossing, the rail and roadway signals would need to be interconnected so that train movement will pre-empt roadway signals in order to clear a crossing for the train's entry. Access to the proposed power plant site should be designed such that no new at-grade rail crossing is required.

6.13.3 IMPACTS

6.13.3.1 Construction Impacts

Power Plant Site

Based on the necessary permitting and design requirements, DOE expects that the earliest year that construction would begin on the proposed power plant site would be 2009 (FG Alliance, 2006e). Table 6.13-5 shows 2009 No-Build traffic volumes, which DOE projected to the construction year by applying a background growth rate of 0.5 percent per year to 2005 volumes. DOE determined this growth rate by reviewing other TxDOT project EISs and study documentation (TxDOT, 2006a, 2006b).

Table 6.13-5. 2009 Average Daily and Peak Hour No-Build Traffic Volumes

Roadway	ADT[1] (vpd)	Truck ADT[2] (vpd)	Weekday Peak Hour Volume[1] (vph)	Weekday Peak Hour Truck Volume[3] (vph)	LOS[3]
FM 39	2,703	270	270	27	B
US 79	7,651	765	765	77	A
I-45	29,584	2,958	2,958	296	B
SH 164	2,795	280	280	28	B
US 84	6,631	663	663	66	C

[1] DOE estimate based on 0.5 percent growth per year from 2005.
[2] No truck data were available. DOE assumed 10 percent trucks, which is consistent with surrounding roadways.
[3] DOE used HCS+ to perform capacity analysis.
ADT = average daily traffic; vpd = vehicles per day; vph = vehicles per hour; LOS = Level of Service.

Based on the 2009 No-Build volumes, DOE estimated roadway capacity (Table 6-13.5). Because there is no predicted change in the roadway LOS between the 2005 existing conditions and 2009 No-Build conditions, DOE concluded that there would be no change in LOS at key intersections near the proposed Jewett Power Plant Site. All intersections are expected to continue to operate at LOS C or better.

Over a 44-month construction period (2009 to 2012), the construction workforce site is estimated to average 350 workers on a single shift (FG Alliance, 2006e), with a peak of 700 workers would be anticipated to be on the site working a single shift. DOE assumed that 100 percent of the construction workforce would arrive at the construction site in single-occupant vehicles. For the analysis of construction conditions, DOE used the peak period of construction to estimate the highest level of potential impact during construction.

The majority of trips would use I-45, which provides access to the Dallas-Fort Worth and Houston/Galveston metro areas. The balance of trips would come to the proposed site via US 79 from the west. DOE assumes that access to the proposed site would be provided via FM 39 (FG Alliance, 2006c).

DOE assumed that the construction workforce would work a 10-hour workday, 5 days per week. Construction work force trips would generally occur before the morning peak hours (7:00 am to 9:00 am) and coincide with the afternoon peak hours (4:00 pm to 6:00 pm). It is unlikely that many, if any, trips would occur during mid-day because construction workers typically do not leave a job site during the 30-minute lunch period.

Based on these construction workforce estimates, DOE estimated the percent change in ADT and peak-hour traffic volumes from 2009 No-Build conditions to 2009 construction conditions for likely routes to the proposed site during the expected 44-month construction period (Table 6.13-6). The largest construction traffic impact would occur on FM 39. FM 39 would experience a 53 percent increase in daily traffic during construction of the proposed power plant.

As shown in Table 6.13-6, the number of passenger vehicle trips by construction workers would be relatively small in terms of available roadway capacity, and direct traffic impacts due to construction would be temporary. The roadway that would experience the most direct impact during construction at the proposed Jewett Power Plant Site would be FM 39 because all construction-related trips would use this roadway en route to and from the proposed Jewett Power Plant Site. FM 39 would operate at LOS D (approaching unstable flow) during construction compared to LOS B (reasonably free flow) under 2009 No-Build conditions, which would be inconvenient for travelers on the highway, particularly during peak traffic hours, but is acceptable for a temporary condition during construction (TxDOT, 2006c). Given that the roadways would be operating at LOS D or better, there is no reason to conclude that there would be any notable increase in traffic accidents. The capacity analysis summary for the 2009 Construction Conditions of the project area roadways is shown in Table 6.13-6.

Based on the volumes and LOS on these roadways during construction, the key intersections around the proposed site, identified in Section 6.13.2.1, should be able to accommodate these daily and peak hour traffic volumes at LOS D or better. The ramp termini intersections at I-45 and US 79, as well as the ramps from FM 39 to US 79 could see some temporary change in LOS due to the volumes generated during construction. Changes to traffic signal timings may be required at the US 79/I-45 ramp intersections to accommodate changes in the turning volumes at those intersections.

In addition to worker traffic, materials and heavy equipment would be transported to the proposed site on trucks and via the adjacent rail line. Heavy equipment would remain at the proposed site for the duration of its use. Material deliveries and return trips by empty trucks would likely occur throughout the workday. The area around the proposed Jewett Power Plant Site is served by several large construction material supply firms offering concrete, asphalt, gravel, and fill. DOE did not estimate a specific number of trips by truck from any specific supply location; however, DOE included 40 truck trips per day

(20 entering and 20 exiting the site) in the analysis. Based on the available roadway capacities and the fact that estimated 2009 No-Build LOS are C or better, DOE concluded that 40 truck trips per day would not have a significant direct impact on traffic operations on roadways surrounding the proposed site. Moreover, DOE also concluded that even if the number of trips did occasionally exceed 40 per day, it is highly unlikely that it would result in a significant direct impact on roadways surrounding the proposed site.

Table 6.13-6. 2009 Average Daily and Peak Hour Construction Traffic Volumes

Roadway	ADT[1] (vpd)	Change in ADT[1] (percent)	Peak Hour Volume[2] (vph)	Change in Peak Hour Volume[2] (percent)	LOS[3]
FM 39	4,143	53	974	260	D
US 79	8,399	10	1,131	48	A
I-45	31,024	5	3,662	25	B
SH 164	3,487	25	618	121	C
US 84	6, 631	0	763	0	C

[1] DOE estimate based on peak workforce of 700 workers arriving at site in single-occupancy vehicles, plus 40 truck trips per day (20 entering and 20 exiting the site).
[2] DOE derived peak hour volumes assuming half of all passenger car trips occur in peak hour and truck trips are evenly distributed over a 10-hour construction work day.
[3] DOE used HCS+ to perform capacity analysis.
ADT = average daily traffic; vpd = vehicles per day; vph = vehicles per hour; LOS = Level of Service.

Sequestration Site

The surface extent of the land area above the proposed Jewett Sequestration Site would be located within Freestone and Anderson counties. There would be comparatively less construction activity at the proposed Jewett Sequestration Site and along the CO_2 pipeline connecting the proposed sequestration site with the proposed power plant site, than at the power plant site. Construction traffic to the reservoir would have a negligible effect on roadways and traffic.

Utility Corridors

All underground utilities (potable water, process water, wastewater, natural gas, and CO_2) are proposed to be constructed using open trenching (FG Alliance, 2006c). Though there would be a need for staging areas for this construction, DOE assumes that typical construction techniques would be employed and all roadways would maintain one lane of traffic in each direction during construction. Construction of several of the proposed utility lines (process water, CO_2) could last for approximately four to 12 months (FG Alliance, 2006c), depending on the length of the corridor chosen. During this time there would be minor disruptions to traffic, but they would not create a substantial direct impact to traffic operations.

Construction of the utility lines would require approximately 60 persons for all construction to occur concurrently (FG Alliance, 2006c). In the most conservative case, all construction workers would travel in single-occupant vehicles. Therefore, there would be approximately 120 additional daily trips on the roadway network during construction of the utilities. Assuming that construction operations typically start earlier than the morning peak period of traffic, 60 trips would take place before the morning peak hour. The 60 afternoon trips made by construction workers leaving job sites would likely coincide with the afternoon peak period. Given the proposed locations of the utility corridors, these trips would be spread out on various roadways in the ROI and would not be expected to have any appreciable direct impact on traffic operations.

Transportation Corridors

A new private sidetrack from the Burlington Northern Santa Fe Railroad would be constructed on the proposed Jewett Power Plant Site and would require approximately nine to 11 months to complete that could be spread over more than one construction season. It is estimated that up to 18 construction workers would be traveling to and from the site, resulting in an additional 36 trips per day on the roadway network. The other 18 trips would take place before the morning peak period, assuming that construction activities typically begin earlier than the regular work day. Eighteen of those trips would occur during the afternoon peak period, assuming a 10-hour work day. Given that all roadways would be operating at LOS D or better during construction (see Table 6.13-6), these trips would not be expected to appreciably change traffic operations on the roadway network.

During connection of the new rail loop to the existing Burlington Northern Santa Fe Railroad, railroad safety flaggers would be required. The construction could have some temporary impacts on Burlington Northern Santa Fe Railroad operations while the connection between the private sidetrack and the mainline is completed. This temporary impact could be avoided by completing the connection during hours when the Burlington Northern Santa Fe track has the lightest expected traffic.

6.13.3.2 Operational Impacts

The proposed FutureGen Project is expected to begin operating in 2012 (FG Alliance, 2006e). Table 6.13-7 shows 2012 No-Build traffic volumes, which DOE projected to the opening year by applying a background growth rate of 0.5 percent per year to 2005 volumes. This growth rate was determined through review of other TxDOT project documentation (TxDOT, 2006a, 2006b). Based on the 2012 No-Build volumes, the capacity of each roadway was estimated (Table 6.13-7).

Table 6.13-7. 2012 Average Daily and Peak Hour No-Build Traffic Volumes

Roadway	2012 No-Build ADT[1] (vpd)	2012 No-Build Truck ADT[1] (vpd)	2012 No-Build Peak Hour Volume[1] (vph)	2012 No-Build Peak Hour Truck Volume[1] (vph)	LOS[2]
FM 39	2,744	274	274	27	B
US 79	7,766	777	777	78	A
I-45	30,030	3,003	3,003	300	B
SH 164	2,837	284	284	28	B
US 84	6,731	673	673	67	C

[1] DOE estimate based on 0.5 percent growth per year from 2005.
[2] DOE used HCS+ to perform capacity analysis.
ADT = average daily traffic; vpd = vehicles per day; vph = vehicles per hour; LOS = Level of Service.

Power Plant Site

The operating workforce for the proposed power plant would be approximately 200 employees, of which 80 administrative personnel would work a regular office day (9:00 am to 5:30 pm), and 40 shift workers would work a daytime shift (7:00 am to 3:30 pm) and each of the two nighttime shifts (FG Alliance, 2006c). The workforce would result in 160 new peak hour trips in both the morning and afternoon. For this analysis, DOE assumed these employees would arrive at the plant in single-occupant vehicles and that the trip distribution would be the same as for the construction worker trips. A majority of these trips would use I-45, which provides access to the Dallas-Fort Worth and Houston/Galveston metro areas. The balance of trips would come to the proposed site via US 79 from the west. Depending on how the proposed power plant is oriented, a single access gate would be located on FM 39 (FG Alliance, 2006c).

A small number of delivery trucks would travel to the proposed power plant to support personnel, and administrative functions and deliver spare parts. Coal would be delivered primarily by rail. Other bulk materials used by the plant and byproducts are expected to be delivered or removed from the proposed Jewett Power Plant Site by truck. DOE estimates that 13 trucks per week would be required for delivery of materials, while 98 trucks per week would be required for removal of byproducts, including slag, sulfur, and ash. DOE estimated the number of trucks required based on the estimated annual quantities of materials/byproducts (FG Alliance, 2006e). Based on these estimates and assuming an even distribution of trucks over each day of the week, materials delivery would require 4 truck trips per day, 2 entering and 2 exiting, and byproduct removal would result in an additional 28 trips per day, 14 entering and 14 exiting. These trips are included in the 2012 Build ADT and peak hour traffic volumes shown in Table 6.13-8. The change in ADT and peak hour volumes between 2012 No-Build and 2012 Build conditions is also shown in Table 6.13-8.

Table 6.13-8. 2012 Average Daily and Peak Hour Build Traffic Volumes

Roadway	2012 Build ADT[1] (vpd)	Change in ADT[1] (percent)	2012 Build Peak Hour Volume[2] (vph)	Change in Peak Hour Volume[2] (percent)	LOS[3]
FM 39	3,176	16	438	60	C
US 79	7,991	3	862	11	A
I-45	30,462	1	3,167	6	B
SH 164	3,045	7	363	28	C
US 84	6,895	2	837	24	C

[1] DOE derived ADT using the maximum operating workforce (200 people; 400 vpd) passenger car trips (FG Alliance, 2006c) and assuming 32 operations-related truck trips daily (16 arriving and 16 exiting the site).
[2] DOE derived peak hour volumes assuming that administration and 1/3 of shift workers arrive in peak hour, and that four truck trips occur in each peak hour.
[3] DOE used HCS+ to perform capacity analysis.
ADT = average daily traffic; vpd = vehicles per day; vph = vehicles per hour; LOS = Level of Service.

These volumes would result in a small direct impact on the roadways surrounding the proposed Jewett Power Plant Site, based on the predicted 2012 Build Conditions capacity analysis summary given in Table 6.13-8. FM 39, which would be the most affected roadway due to the trips made by employees, would operate at LOS C (stable flow) under the 2012 Build conditions compared to LOS B (reasonably free flow) under 2012 No-Build conditions. Given that the roadways would be operating at LOS C or better, there is no reason to conclude that there would be any notable increase in traffic accidents.

Based on the volumes and LOS on these roadways under the proposed operating conditions, DOE concluded that the key intersections around the proposed site should be able to accommodate these daily and peak hour traffic volumes. Changes to traffic signal timings may be required at the US 79/I-45 ramp intersections to accommodate changes in turning volumes at those intersections.

The primary component of materials transport would be the delivery of coal to the plant by rail, using a spur track constructed for the purpose. It is anticipated that coal deliveries would require five 100-unit trains per week, or 10 entering or exiting train trips per week (FG Alliance, 2006e). This would equal a 12 to 14 percent increase in the number of trains on the main line, which currently accommodates 70 to 84 trains per week (10 to 12 freight trains seven days per week) (Walden, 2006).

Sequestration Site

There would be very little operational traffic to and from the proposed Jewett Sequestration Site, and essentially no direct or indirect traffic or roadway impact.

Utility Corridors

The proposed utility corridors would have little or no impacts on traffic operations and roadway LOS once the proposed Jewett Power Plant is operating. There would be no direct impact on traffic unless there is a problem with a utility line that requires open trenching to repair. It is expected that this would be an infrequent occurrence, thus having little to no long-term potential to affect traffic.

Transportation Corridors

The proposed rail connection on the proposed Jewett Power Plant Site would have very little direct impact on the rail operations on the Burlington Northern Santa Fe or Union Pacific main lines. The rail lines have the capacity to absorb the 10 to 11 percent increase in rail traffic.

6.14 NOISE AND VIBRATION

6.14.1 INTRODUCTION

Noise is defined as any sound that is undesired or interferes with a person's ability to hear something. The basic measure of sound is the sound pressure level (SPL), commonly expressed as a logarithm in units called decibels (dB). Vibration, on the other hand, consists of rapidly fluctuating motions having a net average motion of zero that can be described in terms of displacement, velocity, or acceleration. This chapter provides the results of the analyses completed for both noise and vibration. Specific details of the noise and vibration analysis are provided in sequence under each subsection, with the results of the noise analysis presented first followed by those of the ground-borne vibration analysis.

6.14.1.1 Region of Influence

The ROI for noise and vibration includes the area within 1 mile (1.6 kilometers) of the proposed Jewett Power Plant Site boundary and within 1 mile (1.6 kilometers) of the boundaries of all related areas of new construction, including the proposed sequestration site and the utility and transportation corridors.

6.14.1.2 Method of Analysis

This section provides the methods DOE used to assess the potential noise and vibration impacts of construction and operational activities related to the proposed Jewett Power Plant Site, sequestration site, and related corridors. In preparing the noise and vibration analysis, DOE evaluated information presented in the Jewett EIV (FG Alliance, 2006c), estimated increases in ambient noise and ground-borne vibration levels, and evaluated potential impacts on sensitive receptors.

DOE assessed the potential for impacts based on the following criteria:

- Conflicts with a jurisdictional noise ordinance;
- Permanent increases in ambient noise levels at sensitive receptors during operations;
- Temporary increases in ambient noise levels at sensitive receptors during construction;
- Airblast noise levels in excess of 133 dB;
- Blasting peak particle velocity (PPV) greater than 0.5 inches per second (in/sec) (12.7 millimeters per second [mm/sec]) at off-site structures; or
- Exceeding the Federal Transit Administration's (FTA) distance screening and human annoyance thresholds for ground-borne vibrations of 200 feet (61 meters) and 80 velocity decibels (VdB).[1]

Noise Methods

Generally, ambient conditions encountered in the environment consist of an assortment of sounds at varying frequencies (FTA, 2006). To account for human hearing sensitivities that are most perceptible at frequencies ranging from 200 to 10,000 Hertz (Hz) or cycles per second, sound level measurements are often adjusted or weighted and the resulting value is called an "A-weighted" sound level.

The **A-weighted** scale is the most common weighting method used to conduct environmental noise assessments and is expressed as a dBA.

A-weighted sound measurements (dBA) are standardized at a reference value of zero decibels (0 dBA), which corresponds to the threshold of hearing, or SPL, at which people with healthy hearing mechanisms can just begin to hear a sound. Because the scale is logarithmic, a relative increase of

[1] FTA threshold standards are not applicable to this project, but were used as a basis for comparing effects.

10 decibels represents an SPL that is nearly 10 times greater. However, humans do not perceive a 10-dBA increase as 10 times louder; rather, they perceive it as twice as loud (FTA, 2006). Figure 6.14-1 lists measured SPL values of common noise sources to provide some context.

The following generally accepted relationships (***MTA, 2004***) are useful in evaluating human response to relative changes in noise level:

- A 2- to 3-dBA change is the threshold of change detectable by the human ear in the ambient conditions;
- A 5-dBA change is readily noticeable; and
- A 10-dBA change is perceived as a doubling or halving of the noise level.

The SPL that humans experience typically varies from moment to moment. Therefore, a variety of descriptors are used to evaluate noise levels over time. Some typical noise descriptors are defined below:

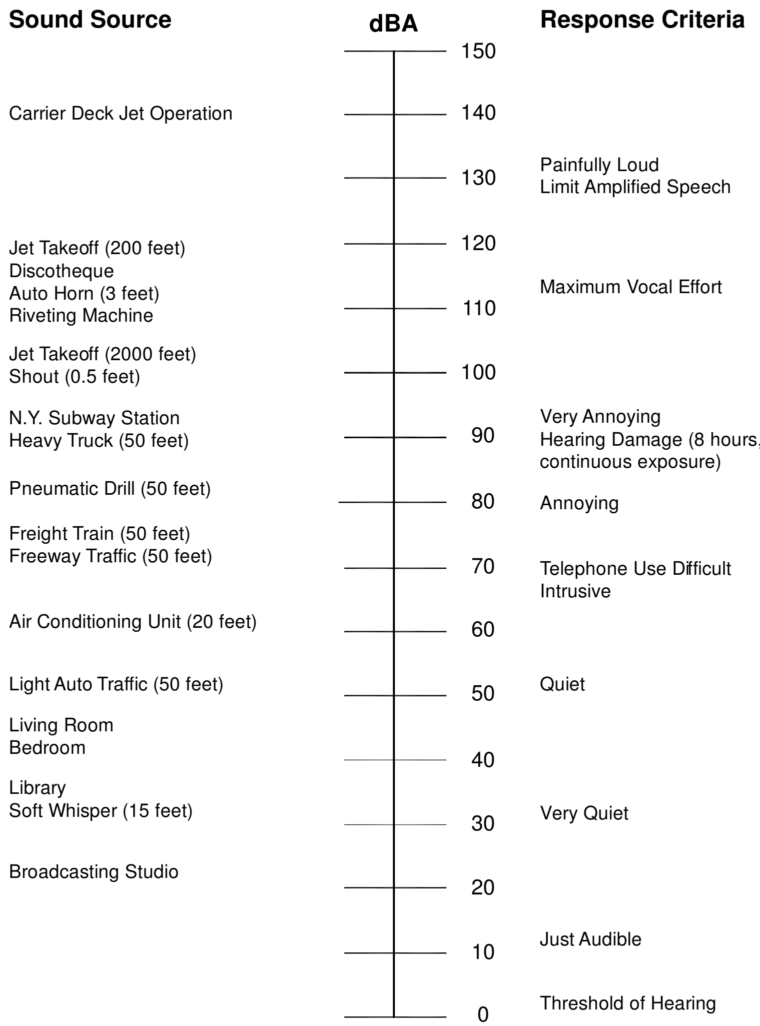
- L_{eq} is the continuous equivalent sound level. The sound energy from fluctuating SPLs is averaged over time to create a single number to describe the mean energy or intensity level. Because L_{eq} values are logarithmic expressions, they cannot be added, subtracted, or compared as a ratio unless that value is converted to its root arithmetic form.
- L_{max} is the highest, while L_{min} is the lowest SPL measured during a given period of time. These values are useful in evaluating L_{eq} for time periods that have an especially wide range of noise levels.

For this analysis, DOE evaluated noise levels generated by stationary (i.e., fixed location) sources such as construction-related and power plant operating equipment, and mobile (i.e., moving) sources such as construction-related vehicle trips and operational deliveries by rail, car, and truck. DOE predicted stationary source noise levels during construction and normal plant operations at sensitive receptor locations in direct line-of-sight of proposed project facilities by summing anticipated equipment noise contributions and applying fundamental noise attenuation principles. DOE used the following logarithmic equation (Cowan, 1994) to predict noise levels at the sensitive receptor locations selected for the stationary source analysis:

$SPL_1 = SPL_2 – 20 \text{ Log } (D_1/D_2) – A_e$, where:

- SPL_1 is the noise level at a sensitive receptor due to a single piece of equipment operating throughout the day;
- SPL_2 is the equipment noise level at a reference distance D_2;
- D_1 is the relative distance between the equipment noise source and a sensitive receptor;
- D_2 is the reference distance at which the equipment level is known; and
- A_e is a noise level reduction factor applied due to other attenuation effects.

DOE compared the calculated results to the existing ambient noise levels. Because the FutureGen Project is in the early pre-design stage, noise specification data for the power plant operating equipment is not available. In lieu of project-specific data, DOE used comparable noise data predicted for the proposed Orlando IGCC power plant facility (DOE, 2006) to estimate the increase in the noise level at sensitive receptors in the vicinity of the proposed Jewett Power Plant Site. Any residences, schools, hospitals, nursing homes, houses of worship, and parks within the 1-mile (1.6-kilometer) ROI were considered sensitive receptors in this analysis.



Source: ***NYSDEC, 2000***

Figure 6.14-1. SPL Values of Common Noise Sources

For mobile sources, DOE estimated noise levels using traffic noise screening ***and analysis*** techniques to compare the vehicle traffic mix data for the future Build and No-Build traffic conditions on each roadway studied. DOE calculated the ratio of the future Build and future No-Build traffic volumes using the following equation (FHWA, 1992):

Predicted Change in Noise Level (dBA) = 10 Log (Future Build PCE/Future No-Build PCE), where one heavy truck = 28 passenger car equivalents (PCEs)

In applying this equation, a doubling of traffic means future Build conditions are predicted to be twice the future No-Build condition. A doubling in the vehicle traffic volume would result in a 3-dBA increase in the noise level (10 Log [2/1] = 3 dBA). A ten-fold increase in traffic would result in a +10 dBA change (10 Log [10/1] = 10 dBA).

For this analysis, DOE considered a 3-dBA increase in the ambient noise level at sensitive receptors located adjacent to the project-related transportation routes as a threshold indicating that further detailed noise analysis (e.g., modeling) would be needed***. DOE then used FHWA's Traffic Noise Model, Version 2.5 (TNM), which considers roadway geometry, vehicle speed, and traffic direction, to predict the increase in noise generated by project-related traffic and*** to determine if the impacts would be potentially significant. Otherwise, DOE concluded that the anticipated increase in noise levels resulting from project-related activities would not be noticeable and would require no further analysis.

Vibration Methods

> **Vibration** is an oscillatory motion that can be described in terms of displacement, velocity, or acceleration.

The concept of vibration is easily understood in terms of displacement as it relates to the distance a fixed object (e.g., floor) moves from its static position. Common measurements of velocity are not well understood by the average person. For example, the preferred vibration descriptors used to assess human annoyance/interference and building damage impacts are the root-mean-square (RMS) vibration velocity level and the PPV, respectively. The RMS vibration level is expressed in units of VdB. The PPV, expressed in in/sec or mm/sec, represents the maximum instantaneous speed at which a point on the floor moved from its static position (FTA, 2006).

Generally, the background vibration velocity level encountered in residential areas is 50 VdB or lower (FTA, 2006). The threshold of perception for humans to experience vibrations is 65 VdB. Typical sources of vibration include the operation of mechanical equipment indoors, slamming of doors, movement of trains on rails, and ground-breaking construction activities such as blasting and pile driving. The effects on vibration-sensitive receptors from these activities can range from feeling the window and the building floor shake, to rumbling sounds, to causing minor building damage (e.g., cracks in plaster walls) in rare cases. The criterion for minor structural damage is 100 VdB, or 0.12 in/sec (3.05 mm/sec) in terms of PPV, for fragile buildings (FTA, 2006).

DOE performed the vibration analysis using progressive levels of review. Initially, DOE prepared a vibration screening analysis to evaluate the potential effects that ground-borne vibrations generated by project-related construction and operational activity would have on adjacent sensitive receptors, including humans, buildings, and vibration-sensitive equipment. If the results of this preliminary analysis showed that screening thresholds would be exceeded, DOE applied further vibration study methods to determine if the impacts would be potentially significant.

6.14.2 AFFECTED ENVIRONMENT

6.14.2.1 Power Plant Site

The proposed Jewett Power Plant Site and the land area within 1 mile (1.6 kilometers) of the site boundary are located in a rural environment. The predominant land uses in the ROI include power production, lignite mining, and gas well exploration drilling. The site consists of undeveloped and gently rolling land, utility pipelines, unimproved roads, and structures relating to gas well activities. No residential receptors are located within the footprint or the ROI of the proposed Jewett Power Plant Site. The Wilson Chapel and associated cemetery are located approximately 0.25 mile (0.4 kilometer) north of the proposed Jewett Power Plant Site, as shown in Figure 6.14-2. There are no schools or other sensitive receptors in the ROI.

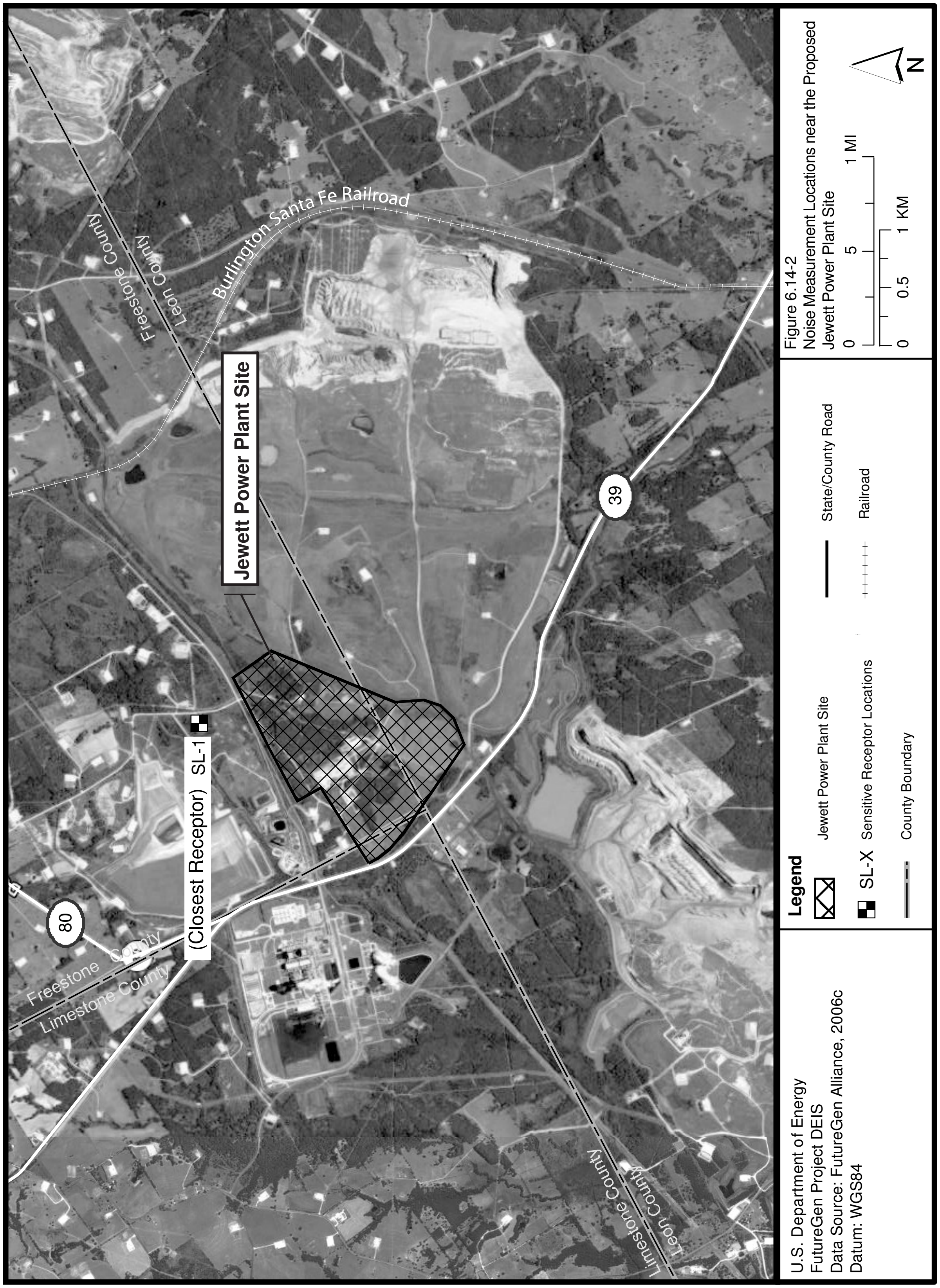


Figure 6.14-2
Noise Measurement Locations near the Proposed Jewett Power Plant Site

Ambient noise sources within the site and ROI include existing electric generating and mining facilities, traffic on Farm-to-Market Road (FM) 39, and the Burlington Northern Santa Fe rail spur leading to the electric generating facility. ***Ambient*** noise levels ***in the vicinity of*** the site are expected to be generally typical of a rural environment ranging from a L_{eq} of 47 to 57 dBA (NYSDEC, 2000). ***On June 19, 2007, DOE measured the ambient noise environment near the SL-1 sensitive receptor location and recorded a noise level of 48 dBA. Measurements were taken using a Quest Model 2900, Type II sound level meter that was equipped with a windscreen and mounted on a tripod approximately 4 feet (1.2 meters) above ground level, away from any reflective surface. DOE field calibrated the sound level meter and noted the weather conditions (e.g., temperature, wind) before sampling the ambient noise environment at SL-1. Broadband noise levels were collected over a 10-minute sampling period.***

Vehicular traffic (e.g., commercial trucks and passenger cars) along FM 39 could generate slightly elevated noise levels in this area during the daytime peak hours (6:00 AM to 8:00 AM and 5:00 PM to 7:00 PM). In addition, periodic noise level spikes exceeding 75 dBA may be generated when trains from the Burlington Northern Santa Fe pass by this area (FG Alliance, 2006c).

6.14.2.2 Sequestration Site

The proposed CO_2 sequestration site is located in Cherokee and Anderson counties in a semi-rural area about 33 miles (53.1 kilometers) northeast of the proposed power plant, 20 miles (32.2 kilometers) east of Interstate 45 (I-45), and about 60 miles (96 kilometers) east of Waco. Land uses in this area are primarily agricultural farming with only a few residences and the Coffield State Prison Farm (FG Alliance 2006c). As such, ambient noise levels in this area are generally expected to be typical of a rural environment ranging from a L_{eq} of 47 to 57 dBA.

6.14.2.3 Utility Corridors

The related areas of new construction associated with the proposed power plant include a possible water supply pipeline and a CO_2 pipeline corridor. If process water is not obtained by installing wells on site, the water supply corridor would extend less than 1 mile (1.6 kilometers) to the southeast of the proposed Jewett Power Plant Site. The proposed CO_2 pipeline corridor involves a 52- to 59-mile (83.7- to 95-kilometer) network of segment connections traversing rural areas dominated by rolling topography and shaped by numerous streams, creeks, and post oak woodland vegetation. The transmission line would connect to a 345-kV transmission line on the northwestern boundary of the site or a 138-kV line within a few miles of the site. The ambient noise environment along these corridors is likely the same as the proposed sequestration site.

6.14.2.4 Transportation Corridors

There are no residential receptors along the local access route (FM 39) leading to the proposed Jewett Power Plant Site. The major thoroughfares that intersect FM 39 are United States Highway (US) 79 and State of Texas Highway (SH) 164.

6.14.2.5 Regulatory Setting

The State of Texas and the counties of Leon, Limestone, and Freestone do not have noise or vibration standards applicable to activities proposed for the FutureGen Project. However, the FTA establishes guidelines and threshold standards for noise and vibration related to projects affecting transit facilities (FTA, 2006).

FTA established guidelines and methods to perform noise and vibration impact assessments for proposed projects involving transit facilities (FTA, 2006). To assess noise impacts, FTA recommends applying the same methods described in Section 6.14.1.2 to identify receptors that the project could potentially affect and to estimate noise contributions from project related mobile and stationary sources. To determine if the proposed transit project would significantly increase ambient conditions at a particular sensitive receptor, FTA established incremental change and absolute daytime/nighttime limits. For vibration, FTA recommends progressive levels of analysis depending on the type and scale of the project, the stage of project development, and the environmental setting. Such analysis typically begins with a screening process, which considers relative distance information between the source of ground-borne vibrations and the vibration-sensitive receptors that have been identified. If the relative distance from the source of ground-borne vibrations to a residential receptor is greater than 200 feet (61 meters), FTA guidelines indicate that it is reasonable to conclude that no further consideration of potential vibration impacts is needed (FTA, 2006). Otherwise, FTA provides criteria to assess the impacts of human annoyance, as well as building and vibration-sensitive equipment damage using detailed quantitative analyses to predict VdB and PPV values generated by the proposed project.

6.14.3 IMPACTS

6.14.3.1 Construction Impacts

Construction of the proposed Jewett Power Plant is expected to be typical of other power plants in terms of schedule, equipment used, and other related activities. Noise and vibration would be generated by a mix of mobile and stationary equipment noise sources, including bulldozers, dump trucks, backhoe excavators, graders, jackhammers, pile drivers, cranes, pumps, air compressors, and pneumatic tools during construction of the proposed power plant and the related utilities. For the purposes of this analysis, DOE considered the proposed project site an area-wide stationary source with construction equipment operating within its boundary. The results of DOE's noise and vibration analyses show that, in the absence of mitigation, the proposed project would result in significant ambient noise level increases at the non-residential sensitive receptors located within the 1-mile (1.6-kilometers) ROI. There are no residential receptors within the ROI. Mobile source impacts would not be anticipated because there are no sensitive receptors associated with the transportation corridors.

Power Plant Site

Noise levels generated during construction at the proposed Jewett Power Plant Site would vary depending upon the phase of construction. Typical power plant construction activity entails the following phases:

- Site preparation and excavation;
- Foundation and concrete pouring;
- Erection of building components; and
- Finishing and cleanup.

DOE anticipates that construction noise contributions would be greatest at the site during the initial site preparation and excavation phase due to the almost constant loud engine and earth breaking noises generated by the use of heavy equipment such as a backhoe excavator, earth grader, compressor, and dump truck. In addition, noise level increases are anticipated along the off-site routes leading to the site because of entry/exit truck movements, especially during the foundation and concrete pouring construction phase. The other phases would generate less audible noise because the equipment used for these activities (e.g., crane) generally would be transient in nature or would not generate much noise. Table 6.14-1 provides standard noise levels for construction equipment measured at a reference distance of 50 feet (15.2 meters).

To evaluate the potential maximum effects of the anticipated noise level increases on the ***closest*** sensitive receptor located to the north of the site boundary, DOE predicted equipment source noise levels using the logarithmic equation described in Section 6.14.1.2. First, the combined noise level expected from the three noisiest pieces of equipment (excavator, grader, and dump truck) used during the initial phase of construction was attenuated over ***the*** relative distance ***of 0.25 mile (0.4 kilometer)*** from the ***northern*** site boundary to the Wilson Chapel ***(SL-1).***

Table 6.14-1. Common Equipment Sources and Measured Noise Levels at a 50-foot (15-meter) Reference Distance

Equipment	Noise Level in dBA
Backhoe Excavator	85
Bulldozer	80
Grader	85
Dump Truck	91
Concrete Mixer	85
Crane	83
Pump	76
Compressor	81
Jackhammer	88
Pile Driver	101

dBA = A-weighted decibels.
Source: Bolt***, Beranek, and Newman***, 1971.

The existing ambient ***noise level measured at SL-1*** and ***the*** distance-attenuated ***equipment*** noise level were then logarithmically summed to predict estimated noise levels at the receptor location, as shown in Table 6.14-2. This represents a very conservative (that is, a maximum) noise prediction estimate because sound waves generated by the noisiest pieces of equipment are assumed to start at from the site boundary and continuously propagate in open air. In addition, the result does not account for any decibel-reducing factors due to atmospheric and ground attenuation effects.

A comparison of the predicted noise level ***generated by construction equipment*** with the ***measured*** ambient noise level at SL-1 shows that construction of the proposed Jewett Power Plant would be noticeable because the incremental change from the existing condition would be 1*4.7* dBA**.** As noted earlier, a noise level increase of 10 dBA is perceived as a doubling of the noise level, while a 5 dBA increase is readily noticeable to the human ear. DOE does not consider the noise level increase at the chapel to be ***a*** major impact because the chapel is seldom used. Most impacts could be avoided at ***this*** sensitive receptor if loud construction activity at the proposed power plant site is scheduled around any funeral proceedings. There are no residences or schools within the radius corresponding to a greater than 3 dBA increase in noise level.

Table 6.14-2. Estimated Noise Level at Selected Receptor Locations

Sensitive Receptor	Relative Distance in miles (kilometers)	Existing Ambient Noise Level (dBA)	Combined Equipment Noise Level (dBA)	Equipment Noise Level Attenuated by Distance (dBA)	Estimated Noise Level (dBA)	Change in dBA
SL-1	0.25 (0.4)	***48***	93[1]	64.6	64.*7*	+1*4.7*

[1]Combined equipment noise level is 93 dBA at 50 feet (15 meters) from source.

During power plant startup, steam blowdown would be required toward the end of the construction phase. The blowdown activity would consist of several blows to test the IGCC system, including the gasifier steam lines, HRSG, and steam turbine. DOE anticipates that very loud noises as high as 102 dBA would be generated during all steam blows. The blowdown noise is assumed to originate at the center of the property and would attenuate to approximately 70 dBA at the property boundary. The noise would attenuate to approximately 65 dBA at the closest sensitive receptor (SL-1)**,** resulting in an increase of 1*7* dBA compared to the existing ambient noise level. No residences or schools exist within the ROI and any increase in noise level at the nearest residence or school would be less than 3 dBA. Precautionary measures that could be taken to mitigate impacts include limiting steam blows to the daytime hours and providing advance notice to those who manage the chapel and ***associated*** cemete***ry*** before beginning plant blowdown activity. Blowdown activities generally would last no more than 2 weeks.

DOE anticipates no vibration impacts at sensitive receptors during construction because the closest vibration-sensitive receptors, including humans, buildings, and sensitive equipment are not located within the 200-foot (61-meter) distance screening and human annoyance threshold for ground-borne vibrations defined by FTA guidance (2006).

Sequestration Site

Construction at the sequestration site would be limited to the installation of CO_2 injection wells. No sensitive receptors are close enough to the proposed injection well locations for noise or vibration impacts to occur. Noise level increases during construction would be less than 3 dBA at the nearest residences.

Utility Corridors

Transmission Corridors

Construction of the proposed transmission line in any of the corridor options would occur on the northwestern boundary or within a few miles of the site. No major noise and vibration impacts are anticipated, although a temporary increase in noise due to construction would occur. No major noise and vibration impacts are anticipated at the chapel and cemetery because of their distance from the corridors and the temporary duration of construction. Temporary construction activities would include activities such as installing a substation or constructing a few miles of new transmission to intersect with an existing transmission line (FG Alliance, 2006c).

Pipeline Corridors

Trench excavations to install the process/potable water and CO_2 pipelines would occur at a rate of 1 mile/week (1.6 kilometer/week). Construction of CO_2 pipelines along the 52- to 59-mile (83.7- to 95-kilometer) network has been divided into workable segments. During this period, elevated noise levels would be experienced by sensitive receptors located in the vicinity of the proposed pipeline corridor sites. However, due to the temporary and linear nature of the pipeline construction, minimal noise and vibration impacts would be anticipated. Equipment used for these types of short-term linear and limited ground disturbance construction activities includes an excavator and a dump truck.

Transportation Corridors

No residential receptors are located along the local access route (FM 39) leading to the proposed Jewett Power Plant Site and no receptors would be affected. The major thoroughfares that intersect FM 39 are US 79 and SH 164. Project-related vehicular traffic would likely increase the existing ambient noise levels along these roadways.

During construction of the rail spur loop, the noise and vibration impacts would be the same as described for the proposed power plant site.

6.14.3.2 Operational Impacts

The projected noise levels calculated using the noise screening and analysis methods described in Section 6.14.1.2 show that none of the criteria listed in Section 6.14.1.2 would be exceeded due to the operation of the proposed power plant facility. DOE expects impacts would be minimal at the closest non-residential sensitive receptor, and DOE expects no operational impacts at the constructed CO_2, natural gas, cooling and potable water pipeline corridors because they would be buried underground. The electrical transmission line may generate some additional noise to the existing ambient environment; however, the results of the impacts analysis show that any impacts would be minimal.

Power Plant Site

The principal equipment noise sources during plant operation include the gas combustion turbine/generator, steam turbine/generator, heat recovery systems, turbine air inlets, exhaust stack, six-cell mechanical-draft cooling tower, coal crusher, coal mill, pumps (e.g., feed, circulating), fans, and compressors, as well as noise from piping flow and flared gas. For the most part, these noise sources would be enclosed inside of a building. In addition, noise sources within the building would be fitted with acoustical enclosures or other noise dampening devices to attenuate sound. Conversely, noise generated by equipment installed without full enclosures and exposed to the outside environment (e.g., flare) could potentially increase the ambient noise levels in the surrounding community.

To determine the impacts of normal plant operations, DOE used a noise prediction algorithm to estimate projected equipment noise contributions at the closest sensitive receptor location. Because the FutureGen Project is in the early pre-design stage, noise specification data for the power plant operating equipment was not available. DOE used comparable noise data estimated for the proposed Orlando IGCC power plant facility (DOE, 2006) to determine the potential effects of operational noise on sensitive receptors in the vicinity of the proposed Jewett Power Plant Site. Using the predicted noise level of 53 dBA at 0.6 mile (1.0 kilometer) that was obtained in the model run completed for the Orlando gasification project (DOE, 2006), DOE used the logarithmic distance attenuation formula to derive an estimated source noise level of 89 dBA for the proposed Jewett Power Plant.

DOE applied the source noise level to the proposed 400-acre (162-hectare) site to compute the attenuated noise level at the property boundary, assuming the noise sources would be at the center of the property. Based on a relative distance of 0.4 mile (0.6 kilometer) from the center of the property to the site's perimeter, DOE predicted noise levels of 57 dBA and 52 dBA at the property boundary and at the closest noise-sensitive receptor (SL-1), respectively. The predicted noise level at SL-1 ***would cause*** the ambient noise level at the chapel ***to incrementally change by up to 5.5 dBA***. As a result, operational activity at the proposed Jewett Power Plant would ***be readily noticeable to people attending any service held at the chapel***. ***As previously stated in Section 6.14.3.1,*** DOE ***does not consider the noise level increase at the chapel to be a major impact because the chapel is seldom used.***

During coal deliveries, noise would be generated by unloading/loading activities such as the movement of containers, placement of coal feedstock on conveyor systems, and surficial contact of rail containers with other metallic equipment. Based on the estimated number of coal deliveries anticipated for the proposed power plant site, DOE estimated an hourly Leq of 69 dBA from unloading/loading activities at the rail yard using the noise prediction equations listed in Table 5-6 of FTA's guidance document (FTA, 2006). To determine the maximum effects on nearby receptors, DOE assumed that the rail yard noise would occur along the site boundary closest to the nearest sensitive receptor. Adding the predicted values for plant operational noise at the site boundary (59 dBA) to that of rail yard noise, a combined noise level of 69 dBA was estimated to be generated at the site boundary during unloading/loading activity. At the closest receptor (SL-1), noise from unloading/loading operations at the rail yard noise would attenuate to 41 dBA, which is lower than the existing ambient L_{eq} of ***48*** dBA. As such, the anticipated rail yard noise from the proposed power plant site would not be noticeable at the chapel ***because the resultant increase in noise would be less than 3 dBA***.

During unplanned or unscheduled restarts of the power plant, combustible gases would be diverted to the flare for open burning. Potential noise sources from flare operation that could affect nearby receptors include steam-turbulent induced noise in piping flow and noise generated by pulsating or fluttering flames from the incomplete combustion of the gases. These noise sources could temporarily increase the ambient noise levels in the vicinity of the flare to a range of 96 to 105 dBAs. Positioning the flare unit at a location farthest from a receptor and implementing measures to control the flow of flare gas or steam through piping connected to the flare unit and the incomplete combustion of gases would reduce any potential impacts. Measures to minimize these short-term impacts would be addressed during the final conceptual design of the IGCC power plant.

The foregoing analysis does not include additional intermittent noise and vibrations that may be generated by rail car shakers if they are used to loosen coal material from the walls of the rail cars during unloading. Typically, the shakers are mounted on a hoist assembly and are used intermittently for a 10-second period to induce material movement in the rail car (Bolt***, Beranek, and Newman***, 1984). Pneumatic or electric rail car shakers could generate noise levels up to 118 dBA (VIBCO, Undated-a; VIBCO, Undated-b; Western Safety Product, 2007). If the shaker is used on every rail car, it is estimated that the shaker would be used 253 to 428 times per week. Final design of the coal handling equipment should consider the noise and vibration contributions from the rail car shakers.

Sequestration Site

Operations at the sequestration site would entail pumping CO_2 underground. Only minimal noise impacts would be anticipated during operation and maintenance at the injection well point. No noise impacts would be anticipated in the remainder of the proposed sequestration site because there would be little or no activity there. Noise level increases during construction would be less than 3 dBA at the nearest residences.

Ground-borne vibrations could be experienced by nearby receptors during borehole micro-seismic testing and surface seismic surveys performed at the sequestration injection site.

Utility Corridors

Transmission Corridors

No notable impacts would be anticipated from operation of the electrical transmission lines. However, under wet weather conditions, the transmission lines may generate audible or low frequency noises, commonly referred to as a "humming noise." The audible noise emitted from transmission lines is caused by the discharge of energy (corona discharge) that occurs when the electrical field strength on the conductor surface is greater than the "breakdown strength" (the field intensity necessary to start a flow of electric current) of the air surrounding the conductor. The intensity of the corona discharge and the resulting audible noise are influenced by atmospheric conditions. Aging or weathering of the conductor surface generally reduces the significance of these factors.

Corona noise is caused by partial discharge on insulators and in air surrounding electrical conductors of overhead power lines.

Corona noise would not be noticeable because humans are generally insensitive to low frequency noise. However, in some cases, corona noise could be annoying to receptors that are located very near the transmission lines. To mitigate this occurrence, transmission lines are now designed, constructed, and maintained to operate below the corona-inception voltage.

Pipeline Corridors

The CO_2 pipeline would be buried except where it is necessary to come to the surface for valves and metering. Although valve spacing has not been determined at this time, a typical distance between metering stations is 5 miles (8 kilometers). Typically, these features are installed on concrete pads and surrounded by fencing. Alternatively, these features could be enclosed in metal buildings. These features do not have to be above ground; it is not uncommon for valves and meters to be located below grade in concrete vaults. Limited noise impacts from equipment above ground would be anticipated along the proposed CO_2 pipeline corridor during plant operation.

No noise or vibration impacts would be anticipated at the other proposed pipeline corridors during plant operation.

Transportation Corridors

Similarly to what has been described for the construction period, no noise impacts from operations would be anticipated at project-related transportation roads or rail corridors.

There are no receptors along the local access route (FM 39) leading to the proposed Jewett Power Plant Site. Five 100-unit trains per week for coal deliveries would use the Burlington Northern Santa Fe. Based on estimated noise levels listed in FTA's guidance document (FTA, 2006), L_{max} values ranging from 76 to 88 dBAs are anticipated from the locomotive, rail cars, whistles/horns, and track switches/crossovers as the freight train passes by any nearby receptor. The L_{max} values are based on an operating speed of 30 mph (48.3 kmph), as measured approximately 50 feet (15.2 meters) from the track's centerline. Comparing the number of additional rail trips projected for coal deliveries during plant operations with the existing rail trips (70 to 84 trains per week), DOE estimated that the number of trains on the line would increase by 12 to 14 percent (less than 2 additional trains per day).

No vibration impacts are anticipated because the closest vibration-sensitive receptors, including humans, buildings, and sensitive equipment, are not located within the 200-foot (61-meter) perimeter defined by FTA's distance screening threshold guidance (FTA, 2006). The closest vibration-sensitive receptor that could possibly be affected by ground-borne vibrations generated by project-related rail deliveries is approximately 0.25 mile (0.4 kilometer) from the Burlington Northern Santa Fe.

6.15 UTILITY SYSTEMS

6.15.1 INTRODUCTION

This section identifies utility systems that may be affected by the construction and operation of the proposed FutureGen Project at the proposed Jewett Power Plant Site, sequestration site, and related utility corridors. It addresses the ability of the existing utility infrastructure to meet the needs of the proposed FutureGen Project while continuing to meet the needs of other users, and also addresses the question of whether construction of the proposed FutureGen Project could physically disrupt existing utility system features (i.e., pipelines, cables, etc.) encountered during construction.

6.15.1.1 Region of Influence

The ROI for utility systems includes two components: (1) the existing infrastructure that provides process and potable water, sanitary wastewater treatment, electricity, and natural gas to nearby existing users and that would also provide service to the proposed project; and (2) pipelines, transmission lines, and other utility lines that lie within or cross the proposed power plant site, sequestration site, or utility corridors.

6.15.1.2 Method of Analysis

Based on data provided in the Jewett EIV (FG Alliance, 2006c), DOE performed a comparative assessment of the FutureGen Project utility needs versus the existing infrastructure to determine if the proposed project would strain any of the existing systems. Additionally, DOE used data provided in the EIV (FG Alliance, 2006c) to identify the presence of utility infrastructure that could be affected by project construction.

DOE assessed the potential for impacts based on whether the proposed FutureGen Project would:

- Affect the capacity of public water utilities directly or indirectly;
- Require extension of water mains involving off-site construction for connection with a public water source;
- Require water supply for fire suppression that would exceed water supply capacity;
- Affect the capacity of public wastewater utilities;
- Require extension of sewer mains involving offsite construction for connection with a public wastewater system; and
- Affect the capacity and distribution of local and regional energy and fuel suppliers.

6.15.2 AFFECTED ENVIRONMENT

Two or three natural gas wells are located on the power plant site, and one new gas well is currently under construction. In addition to these wells, Railroad Commission of Texas (RCT) records indicate that a minimum of 35 gas wells are located within 1 mile (1.6 kilometers) of the site. Nine gas-gathering lines and one gas transmission line traverse the area within 1 mile (1.6 kilometers) of the site at various locations; one of these lines, approximately 1 mile (1.6 kilometers) north of the proposed power plant site, is a sour gas (i.e., poison gas) line. At least 12 other gas pipelines traverse the area within 1 mile (1.6 kilometers) of the proposed power plant site; four of these pipelines traverse the proposed site itself (FG Alliance, 2006c). The TWDB records reveal 23 documented water wells within 1 mile (1.6 kilometers) of the proposed power plant site; two of these water wells are present within the site boundaries (FG Alliance, 2006c). A dual-circuit, 345-kV transmission line forms the northwestern boundary of the Jewett Power Plant Site. Other transmission lines of 69 kV and above exist within roughly a 30-mile (48.3-kilometer) radius of the site.

The proposed sequestration site is minimally developed both for surface and subsurface uses (ranch land, gas development, agriculture). There are eight small communities located on the sequestration site. The proposed sequestration site would be located adjacent to or, depending on final selected injection sites, within the TDCJ's Coffield property. A minimum of 322 permitted or developed natural gas and oil wells exist within the sequestration site. A minimum of 21 natural gas pipeline systems, two crude oil pipeline systems, and one liquefied petroleum gas pipeline system exist within or cross the area. TWDB records indicate a minimum of 146 documented water wells occurring within the area (FG Alliance, 2006c).

6.15.2.1 Potable Water Supply

No potable water supply currently exists within, or adjacent to, the proposed Jewett Power Plant Site that could be used to provide potable water to the site. A water line currently provides potable water to the nearby NRG Limestone Electric Generating Station, but no additional capacity exists in that line for use by the FutureGen facility. The proposed Jewett Power Plant Site would receive its required 4.2 gallons (15.9 liters) per minute potable water supply from Carrizo-Wilcox aquifer. A sufficient groundwater supply is available from the aquifer. Because these proposed wells would exist on site or on immediately adjacent land, only a small amount of pipeline infrastructure would be required to deliver this water to the site. The adjacent property owner, NRG Texas, has made a commitment to allow drilling and easement rights on company land to the benefit of the FutureGen Project (FG Alliance, 2006c).

6.15.2.2 Process Water Supply

No water supply pipelines currently exist within, or adjacent to, the proposed Jewett Power Plant Site. A groundwater resource assessment indicates that a sustained pumping rate of 3,000 gallons (11,370 liters) per minute is attainable from the aquifer, which would meet project demand. The proposed source of process water for the site would involve development of a well field within the site, or on adjacent land with a process water pipeline no longer than about 1 mile (1.6 kilometers) to the north of the plant site boundary, that would draw from the Carrizo-Wilcox aquifer. The proximity of these wells would mean that only a small amount of pipeline infrastructure would be required to deliver water to the site (FG Alliance, 2006c). The process water source would also be used for fire suppression.

6.15.2.3 Sanitary Wastewater System

No sanitary wastewater lines currently exist near the proposed Jewett Power Plant Site. Sanitary wastewater would be treated and disposed of by constructing and operating an on-site wastewater treatment system to accommodate the 6,000 gallons (22,712 liters) per day capacity.

6.15.2.4 Electricity Grid, Voltage, and Demand

The proposed Jewett Power Plant Site is located in the Electric Reliability Council of Texas (ERCOT) region, which serves a 200,000-square-mile (518,000-square-kilometer) area. ERCOT is the regional reliability organization for this part of the country, charged with operating and ensuring reliability for the transmission system. Within the ERCOT Region, the proposed Jewett Power Plant Site is located in the North Regional Transmission Planning Group.

Peak demand in the ERCOT region occurs during the summer months. As of 2006, the total peak demand in the region was 61,656 megawatts (MW), and this is forecast to increase to 69,034 MW by

2011, representing a growth rate of 2.3 percent per year. If this growth is extrapolated to 2015, peak demand would reach 75,686 MW by 2015. Annual electric energy usage in the region was 299,219 gigawatt-hour (GWh) in 2005 (ERCOT, 2006a). Energy usage is forecast to grow at 2.1 percent per year, which would result in potential energy requirements of 368,338 GWh by 2015 (NERC, 2006).

> Annual average sales of electrical energy in the U.S. are expected to grow from 3,567,000 GWh in 2004 to 5,341,000 GWh by 2030—an increase of about 50 percent (EIA, 2006). The FutureGen Project is scheduled to go on line in 2012 and may contribute toward meeting this need; however, its primary purpose is to serve as a research and development project.

In 2006, ERCOT had 70,498 MW of net resources. This is expected to grow to 70,987 MW by 2011, which would result in very low reserve margins of 4.5 percent in 2011. There are, however, several thermal plants that have been proposed for construction in the region, which together could increase the margin to as much as 23.5 percent (NERC, 2006). Thus, the reserve margin in 2012 is expected to be anywhere between 4.5 percent and 23.5 percent. The proposed Jewett Power Plant Site could connect to either a 345-kilovolt (kV) transmission line bordering the northwest boundary of the site with a new substation or a 138-kV line within about 2 miles (3.2 kilometers) from the site (FG Alliance, 2006c).

6.15.2.5 Natural Gas

An existing, on-site natural gas pipeline (owned and operated by Energy Transfer Corporation) enters the Jewett Power Plant Site at its northwestern corner. The proposed Jewett Power Plant Site would receive its required 1.8 million cubic feet (50,970 cubic meters) per hour natural gas supply from this pipeline. The pipeline has the capacity to deliver 12 million cubic feet (339,802 cubic meters) per hour of natural gas at a pressure of 450 pounds per square inch (3.1 megapascals).

6.15.2.6 CO_2 Pipeline

No CO_2 pipelines exist in the immediate vicinity of the proposed power plant and sequestration sites.

6.15.3 IMPACTS

6.15.3.1 Construction Impacts

During construction, construction equipment, particularly trenching equipment, could accidentally sever or damage existing underground lines. Additionally, construction equipment could damage power or telephone poles and lines if the equipment were to come into contact with them. However, all of the proposed ROWs would have sufficient width to allow for the safe addition of project-related lines without interfering with the existing utilities if standard construction practices are followed. Estimated construction requirements for new utility infrastructure are presented in Table 6.15-1.

Power Plant Site

The 200-acre (81-hectare) envelope, which includes the power plant footprint and railroad loop, could ultimately be located anywhere within the proposed 400-acre (162-hectare) Jewett Power Plant Site. The 200-acre (81-hectare) envelope could accommodate surface facilities required for an on-site sanitary wastewater treatment facility. As shown in Figure 6.15-1, several gas lines currently cross the site. These existing utility systems would need to be taken into account during the final siting of the power plant and related facilities to avoid being damaged. It is possible that some existing lines might need to be rerouted, which would result in a short-term effect on existing gas users.

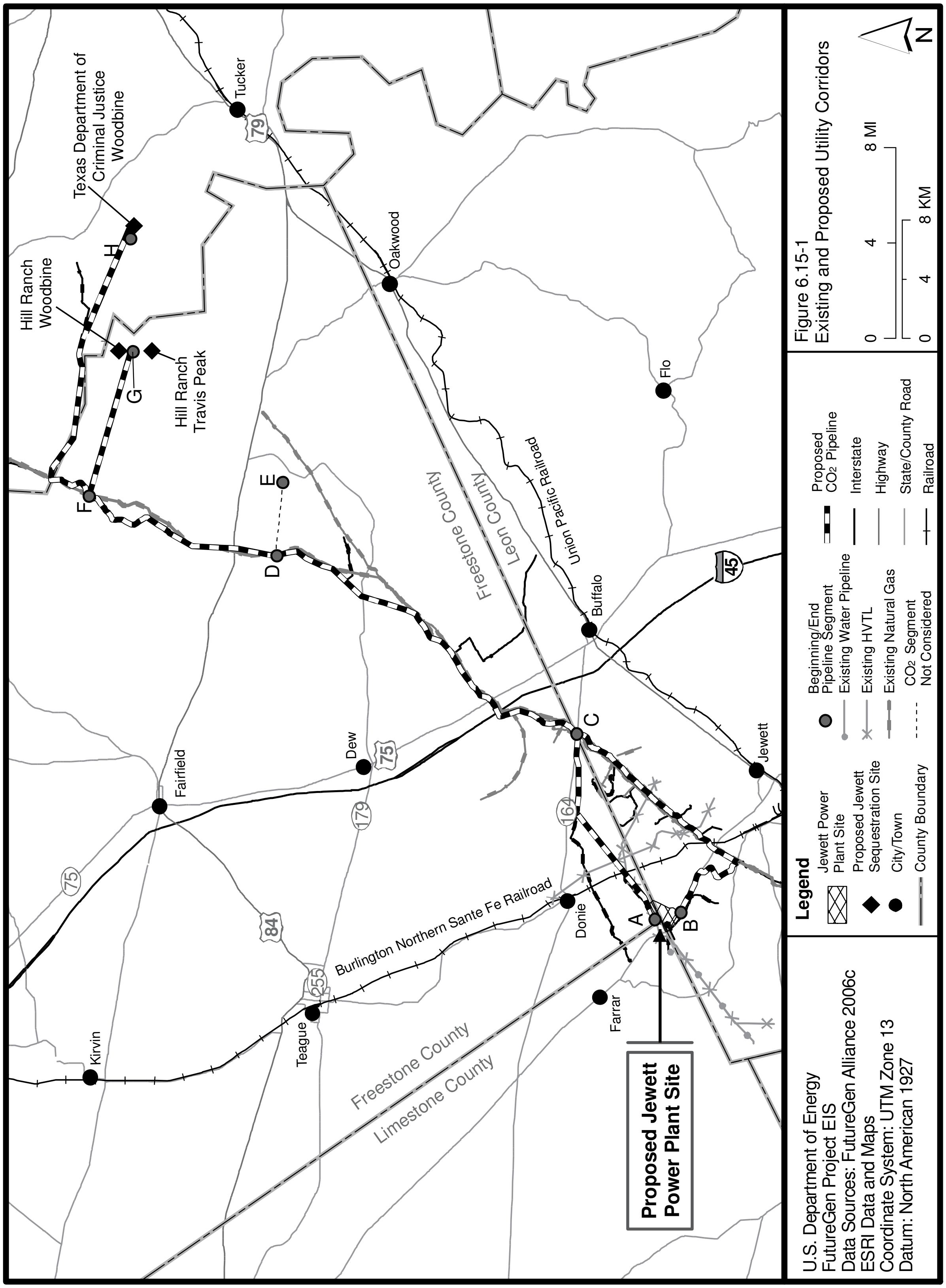


Figure 6.15-1
Existing and Proposed Utility Corridors

Table 6.15-1. Utility System Construction Requirements

Infrastructure Element	Equipment	Duration	Manpower
Potable water pipeline Using same source as process water source	Same as process water	Same as process water	Same as process water
Process water pipeline Proposed groundwater source on site; assume pipeline corridor no longer than 1 mile (1.6 kilometers) north of site boundary. Other options are available (see Section 3.6)	Heavy and light construction equipment, incl. 2 D-6 dozers, trencher, 3 track hoes, 2 rubber-tired back hoes, 3 561 sidebooms, motor grader, and small vehicles and implements	1 week per mile	30 workers
Sanitary Wastewater pipeline Plan to create an on-site wastewater system	n/a	n/a	n/a
Transmission line North Option: 345-kV line along northwestern power plant site boundary with new substation 0.7 mile (1.1 kilometers) South Option: 138-kV line connection 2 miles (3.2 kilometers) in length	Crane for setting poles, bulldozer for earth moving and path leveling, and several bucket trucks	Not estimated	Not estimated
Natural gas pipeline Using existing line that enters site at northwest corner	n/a	n/a	n/a
CO_2 pipeline 52- to 59-mile (83.7- to 95-kilometer) pipe to sequestration site, with spurs to multiple injection wells	Heavy and light construction equipment, incl. 2 D-6 dozers, trencher, 3 track hoes, 2 rubber-tired back hoes, 3 561 sidebooms, motor grader, and small vehicles and implements	1 week per mile	30 workers

n/a = not applicable.
Source: FG Alliance, 2006c.

Sequestration Site

Utility needs at the Jewett Sequestration Site would be limited to the provision of an electric service line to operate pumps and other equipment. Construction at the proposed Jewett Sequestration Site could therefore affect existing utilities or utility systems if appropriate care were not taken during the selection of well sites and during construction.

Utility Corridors

Potable Water Supply

The potable water pipeline corridor has not been selected at this point, and could potentially cross existing oil and gas pipelines in the area. The proposed potable water source would either be an on-site well or a pipeline corridor less than 1 mile (1.6 kilometers) in length.

Process Water Supply

The process water pipeline corridor has not been selected at this point, and could potentially cross existing oil and gas pipelines in the area. The proposed process water source would either be an on-site well or a pipeline corridor less than 1 mile (1.6 kilometers) in length.

Sanitary Wastewater System

Sanitary wastewater would be treated by constructing and operating on-site wastewater system, so no off-site sanitary sewer wastewater pipelines would be required (FG Alliance, 2006c).

Transmission Line System

The corridor that would be used to reach the 138-kV line has not been selected at this point. The electrical transmission line would either connect to a new substation at the site boundary or a new 2-mile (3.2-kilometer) transmission line would be built. Given the number of oil and gas pipelines in the area, it is likely that any new transmission corridor would cross some existing underground pipelines.

Natural Gas Pipeline

An existing natural gas pipeline (owned and operated by Energy Transfer Corporation) enters the site at its northwestern corner, so no off-site natural gas pipeline corridor would be required (FG Alliance, 2006c).

CO_2 Pipeline

The Jewett Power Plant Site would be interconnected to the proposed sequestration reservoir by a CO_2 pipeline between 52 and 59 miles (83.7 and 95 kilometers) long. Several potential corridor segments have been proposed, most of which use existing natural gas pipeline ROWs. Segments A-C and B-C are options that would connect the plant site to the beginning of the common pipeline segments at point "C". Only one of these options would be selected. Figure 6.15-1 shows the proposed pipeline corridor configuration and corridor segments as follows:

- Segment A-C: This segment would begin on the western side of the power plant site and follows about 2 miles (3.2 kilometers) of existing railroad ROW owned by the Burlington Northern Santa Fe Railroad. It continues another 3 miles (4.8 kilometers) along new ROW until it intersects a section of the 12-inch (30.5-centimeter) Pinnacle pipeline. It would then follow this pipeline eastward for another 3 miles (4.8 kilometers) until it joins the primary 24-inch (61-centimeter) trunk of the Pinnacle pipeline.
- Segment B-C: This corridor segment would begin along the southern boundary of the power plant site and extends eastward about 2.5 miles (4 kilometers) along FM 39. It would then follow the ROW of a small-diameter natural gas pipeline owned by Enbridge Pipelines for another 4 miles (6.4 kilometers) until it joins the main Pinnacle pipeline ROW, which continues northward for about 8 miles (12.9 kilometers).
- Segment C-D: This corridor segment would continue to follow the 24-inch (61-centimeter) Pinnacle pipeline northward for about another 15 miles (24.1 kilometers)
- Segment D-E: This segment is no longer being evaluated for the project and is not addressed in this EIS.
- Segment D-F: This segment would continue north along the 24-inch (61-centimeter) Pinnacle pipeline ROW for almost 9 miles (14.5 kilometers).

- Segment F-G: This segment would extend east along new ROW approximately 6 miles (9.7 kilometers) into the proposed sequestration reservoir area.
- Segment F-H: This corridor segment would continue northward along the existing 24-inch (61-centimeter) Pinnacle pipeline ROW for about 2 miles (3.2 kilometers) where it crosses north of the Trinity River. It would then intersect with the corridor of a 12-inch (30.5-centimeter) Pinnacle pipeline, which it would follow east for about 6 miles (10 kilometers). The line would then continue in a generally eastward direction along county highway ROW and TDCJ land for approximately another 6 miles (9.7 kilometers) to the proposed injection well site on TDCJ land.

6.15.3.2 Operational Impacts

All of the proposed operational requirements for potable and process water, sanitary wastewater, and natural gas are well within the capacities of the systems that already exist or would be developed, as described below. A feasibility report from ERCOT (2006b) indicates that operational impacts on the existing transmission system can be handled pending construction of other power plants in the vicinity of the proposed site for the FutureGen Project.

Power Plant Site

Potable Water Supply

No water supply pipelines currently exist near the proposed Jewett Power Plant Site that could be used to provide potable water. A water line currently provides potable water to the nearby NRG Limestone Electric Generating Station, but this line has no additional capacity for use by the proposed FutureGen facility. The proposed primary source of water for the site would involve development of a well field within the site and on adjacent land into the Carrizo-Wilcox aquifer. A groundwater resource assessment conducted by a hydrogeology expert for this area indicates that sustained groundwater pumping of at least 3,000 gallons (11,356 liters) per minute is easily attainable (FG Alliance, 2006c). For 200 employees using 30 gallons (113.6 liters) of potable water a day, the potable water consumption rate would average 4.2 gallons (15.9 liters) per minute, which would be negligible compared to the water supply capacity.

Process Water Supply

The proposed primary source of process water for the site would involve development of a well field within the site and on adjacent land into the Carrizo-Wilcox aquifer. Because these proposed wells would exist on site or on immediately adjacent land, only a small amount of pipeline infrastructure would be required to deliver water to the site. A groundwater resource assessment conducted by a hydrogeology expert for this area (FG Alliance, 2006c) indicates that sustained groundwater pumping of at least 3,000 gallons (11,356 liters) per minute is easily attainable, which would provide adequate process water for the FutureGen Project.

Sanitary Wastewater System

Because the proposed Jewett Power Plant would use a ZLD system, there would be no process-related wastewater associated with the project. The daily sanitary wastewater effluent from the facility would be limited to the sanitary needs of a workforce of 200 employees. Assuming 30 gallons (113.6 liters) of sanitary wastewater per employee per day (FG Alliance, 2006e), the wastewater needs would equal 6,000 gallons (22,712 liters) per day. No wastewater pipelines currently exist near the proposed Jewett Power Plant Site. Sanitary wastewater would be treated and disposed of by construction and operation of a new on-site wastewater treatment system. Therefore, the operational requirements of the project would have no adverse effect on any existing wastewater treatment plant's ability to meet current and future treatment needs.

Transmission Line System

The proposed power plant would provide a nominal 275 MW of capacity. The project would operate at an 85 percent plant factor over the long term, which would result in an average output of 2.0 gigawatt-hour (GWh) of energy per year.

The ERCOT Security Screening Study (ERCOT, 2006b) indicates that the transfer limit of the existing 345-kV line would be greater than 400 MW for the FutureGen Project if no other additional generation resources were connected to the line. Even if 2,500 MW of new generation were added near the site, the transfer limit would still be greater than 400 MW for the FutureGen Project facility if several, mostly minor, upgrades were made. The minor upgrades would not require any new ROW and would not cause an extensive transmission outage during the system upgrades. However, one new 345-kV double circuit line from the Texas New Mexico Power Cooperative (TNP) to Sandow, Texas would be required, which is to be expected if 2,500 MW of new generation were added to the system.

The 138-kV connection through the Farrar substation would allow a transfer limit of 350 MW with three relatively minor megavolt-ampere (MVA) upgrades, which would be sufficient to handle the expected FutureGen Project generation. If these 138-kV lines were not completed by 2012, the application of a Special Protection Scheme or Remedial Action Plan could allow the proposed FutureGen Power Plant to operate in curtailed mode until the needed transmission lines were constructed. Curtailment occurs when the system controller from the Independent System Operator (in this case, ERCOT) observes a thermal or voltage limit overload for an operating situation or, upon performing a contingency analysis, predicts a thermal or voltage limit overload for a planned project. If this occurs ERCOT would notify the participant or power source that new transmission facilities must be completed to avoid this problem. If the facility is predicted to cause an overload, it would have to operate in a curtailed mode. If the power source is already operating and an overload is apparent, ERCOT would issue a directive to curtail the production of energy from a particular facility or more than one facility on a pro-rata basis if several facilities are involved in causing the overload.

The FutureGen Project would aid in meeting regional load, reserve, and energy requirements, and could potentially defer the need for alternative generation sources. However, the FutureGen Project would be capable of meeting only a small percentage of projected load growth over the next 10 years in the ERCOT region. There are several thermal plants that have been proposed for construction in the region, which could increase the margin to as much as 23.5 percent (NERC, 2006). Some of these projects may have received the air quality permits that are required before construction can begin. However, they still lack interconnection agreements, which must also be in place in order for a new project to transmit its power from the plant to consumers.

Natural Gas Pipeline

As previously mentioned, the existing natural gas pipeline that would be used to service the proposed FutureGen facility has the capacity to deliver 200,000 standard cubic feet (5,663 standard cubic meters) per minute of natural gas at a pressure of 450 pounds per square inch (3.1 megapascals). This is more than sufficient to supply the demands of the proposed FutureGen Project (startup: 500 standard cubic feet per minute at 450 psi [3.1 megapascals] [min] to 30,000 standard cubic feet [849.5 standard cubic meters] per minute). Thus, the operational needs of the project would not have an adverse effect on the ability of the system to supply existing and other future demands for natural gas.

CO_2 Pipeline

The pipelines would have sufficient capacity to accommodate the CO_2 expected from the proposed Jewett Power Plant. However, new segments of pipeline and ROW would be required between the plant site and sequestration site.

Sequestration Site

Once construction was completed, the operation of the injection wells at the sequestration site would have no effect on the operation of other utilities present in the area.

Utility Corridors

Once construction was completed, the operation of project-related utilities would have no effect on the operation of other utilities sharing the corridors.

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6.16 MATERIALS AND WASTE MANAGEMENT

6.16.1 INTRODUCTION

Construction and operation of the FutureGen Project would require a source of coal, access to markets for sulfur products, a means to reuse byproducts such as slag, and the ability to capture and sequester CO_2 and dispose of any waste that is generated. This section discusses the capabilities of the proposed Jewett Site to meet each of these requirements. It describes the potential impact of the demands posed by the FutureGen Project on the supply of construction and operational materials in the region. It also discusses the impacts to regional waste management resources.

6.16.1.1 Region of Influence

The ROI includes waste management facilities; industries that could use the FutureGen by-products; and the suppliers of construction materials, coal, and process chemicals used in the construction and operation of the proposed FutureGen Project (power plant, sequestration site, CO_2 distribution system, and associated utilities and transportation infrastructure). The extent of the ROI varies by material and waste type. For example, the ROI for construction material suppliers and solid waste disposal facilities is small (within about 50 miles [80 kilometers] of the proposed Jewett Site) because these types of resources are widely available and the large volumes of materials or waste that would be needed or waste that would be generated are costly to transport over large distances. Treatment and disposal facilities for hazardous waste are less common and the associated ROI includes a multi-state (Texas and Louisiana) area extending 300 miles (483 kilometers) from the site. The ROI for coal and process chemicals, as well as the sulfur product, includes the State of Texas and could extend farther if the cost or value of the commodity makes it economical to transport over a greater distance.

6.16.1.2 Method of Analysis

DOE evaluated impacts by comparing the demands posed by construction and operation of the FutureGen power plant, sequestration site, utility corridors, and transportation infrastructure to the capacities of materials suppliers and waste management facilities within the ROI. The analysis also evaluated regional demand and access to markets for sulfur products. DOE assessed the potential for impacts based on whether the proposed FutureGen Project would:

- Cause new sources of construction materials and operational supplies to be built, such as new mining areas, processing plants, or fabrication plants;
- Affect the capacity of existing material suppliers and industries in the region;
- Create waste for which there are no commercially available disposal or treatment technologies;
- Create hazardous waste in quantities that would require a treatment, storage or disposal (TSD) permit;
- Affect the capacity of hazardous waste collection services and landfills;
- Create reasonably foreseeable conditions that would increase the risk of a hazardous waste release; and
- Create reasonably foreseeable conditions that would increase the risk of a hazardous material release.

DOE reviewed information provided in the Jewett Site EIV (FG Alliance, 2006c) and proposal (FG Site Proposal [Jewett, Texas], 2006). Letters of interest, bid prices, and other prospective material supplier information were identified for use in the EIS. DOE then consulted waste management and material supplier information compiled by state agencies and trade organizations to confirm availability of these resources in the ROI. Uncertainty regarding the specific technologies that would be employed in the FutureGen facility and variability in the potential coal feeds made it difficult to quantify operational materials requirements and waste generation. The maximum value for each item was used in the analysis to bound the potential impacts of the technologies that could be selected. Limited information is available regarding materials requirements or waste generation for construction. DOE used NEPA documentation and design information for facilities of similar scope and size to augment the FutureGen-specific information.

6.16.2 AFFECTED ENVIRONMENT

The Jewett Power Plant Site consists of approximately 400 acres (162 hectares) of mostly open land. The site and its surroundings are located in a rural area where land use has been dominated historically by ranching, gas well activities, and lignite mining activities. The site contains unimproved roads and structures related to gas well activities. It is located northeast of the existing NRG Limestone Electric Generating Station. The Burlington Northern Santa Fe Railway line runs along the northern border of the site. A Phase I ESA found evidence of recognized environmental conditions: underground and aboveground tanks, surface-spillage of petroleum related substances, waste/debris piles, chemical storage areas, and several hundred drums (some were empty, some were full). However, any resulting contamination is not significant with respect to siting another industrial facility on the site (Horizon Environmental Services, 2006).

The TCEQ verified that the proposed site is not on the National Priorities List under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and that no unremediated hazardous waste identified or listed pursuant to Section 3001 of the Resource Conservation and Recovery Act (RCRA) have been disposed of at the proposed Jewett Power Plant Site (TCEQ, 2006a).

6.16.2.1 Construction Materials

A number of suppliers and producers of construction materials are available in the area offering concrete, asphalt and aggregate materials. A sample of the surrounding industry is described in the following subsections, including information on the suppliers' capacities and sources.

Concrete

Large companies supplying concrete services in the area include Transit Mix and A. L. Helmcamp with a combined capacity of 550 cubic yards (420 cubic meters) per hour. Other local suppliers include Young Ready Mix, Boyd Concrete, Texcon, Aggieland Concrete, Texas EMC Products, Houston Concrete Company, and several smaller suppliers (FG Alliance, 2006c).

- Transit Mix Concrete and Materials Company is located in Bryan, Waco, College Station, Hearne, Huntsville, and other central Texas cities. With an on-site mix station, Transit Mix has the capacity to supply 250 cubic yards (191 cubic meters) per hour and average 3,500 cubic yards (2,676 cubic meters) per day. The company has a fleet of more than 450 mixer trucks.
- A.L. Helmcamp can supply concrete at an average of approximately 300 cubic yards (229 cubic meters) per hour. Portable plants are its main source of production.

Asphalt

There are three large asphalt producers in the area of the Jewett Site with a total daily capacity of 8,000 tons (7,257 metric tons) (FG Alliance, 2006c).

- A.L. Helmcamp has the capacity to supply 400 tons (363 metric tons) of asphalt per hour and is able to lay an average of 3,000 to 4,000 tons (2,721 to 3,629 metric tons) per day. The company's asphalt, known as prime, is shipped to its local facilities from Houston and Louisiana. A.L. Helmcamp has two portable asphalt plants, one of which is currently located in Leon County.
- Armor Materials serves Leon and other central Texas counties. There are two locations established within close proximity to the Jewett Site, in Palestine and Corsicana, Texas. Armor Materials has the capacity to supply 2,000 to 2,500 tons (1,814 to 2,268 metric tons) per day. Its asphalt supplies are shipped from Henderson, Texas, and its aggregate supplies come from Oklahoma.
- Young Contractors, Inc. Asphalt produces specific hot mix asphalt for any mix design requirement. Young Asphalt can supply approximately 1,500 tons (1,360 metric tons) of asphalt per day. There are numerous Young Asphalt locations throughout central Texas, including Waco, Hillsboro, and Bryan.

Aggregate and Fill Material

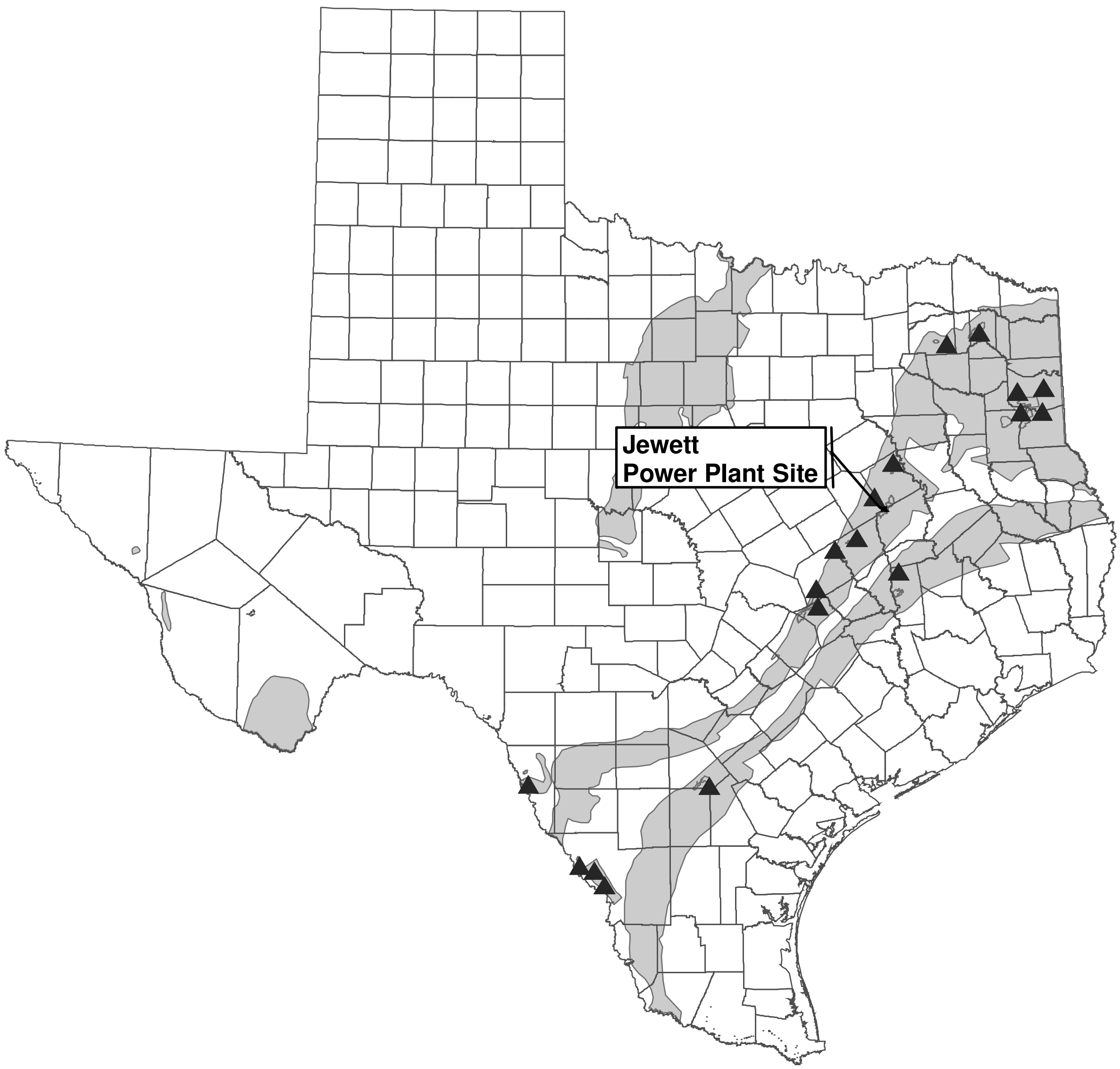
Several sources in central Texas provide gravel, sand, dirt, and rock to suppliers that could serve the proposed project. In particular, Mexia, Texas, is a large source of limestone for this area. Waco and areas north of Bryan, Texas, are also known as good sources for gravel and sand (FG Alliance, 2006c).

- Frost Crushed Stone is a major supplier of limestone for the area, having over 6.5 million tons (5.9 MMT) of fill materials on reserve with an abundance of supplies readily available in Mexia, Texas. Frost Crushed Stone currently provides limestone for highway construction and power plants.
- Young Contractors, Inc. Aggregates (Young Aggregates) supplies all types of base material, crushed limestone aggregates, and sand and gravel products. Young Aggregates has the capacity to produce and supply 10,000 to 15,000 pounds (4,536 to 6,804 kilograms) of fill material per day. Its large trucking fleet can deliver material from its numerous locations throughout central Texas. Currently there are two plants in Mexia, two plants in Waco, and one plant in Bryan that could serve the Jewett Site.
- Trinity Materials, Inc. operates 14 mining facilities located in Texas and Louisiana. Its production consists of gravel, pea gravel, crushed gravel, capillary rock, remix, road base, concrete sand, mason sand, plaster sand, flume sand, and golf course sand.
- A.L. Helmcamp can produce 3,000 to 5,000 yards (2,743 to 4,572 meters) of fill per day. All of their material is gathered within the general area of the job site.

6.16.2.2 Process-Related Materials

Coal Supply Environment

Figure 6.16-1 shows the location of coal mines and probable locations of coal deposits in relation to the proposed Jewett Power Plant Site. The Jewett Site sits in the middle of a vast belt of lignite coal – the largest in North America – that stretches from Louisiana, across Texas, and into northern Mexico. The site is located at the Jewett lignite mine and can take advantage of existing mining infrastructure and truck transport systems.



U.S. Department of Energy
FutureGen Project EIS
Source: FutureGen Alliance, 2006c

Legend

Jewett Power Plant Site
Coal Deposits
Coal Mines

Figure 6.16-1
Coal Resources

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The site has ready access to several types of coal at economical rates. The abundance of low cost, hydrogen-rich Texas lignite, PRB coal, and Gulf Coast petroleum coke provides many fuel options at attractive rates. There is an alternate fuel option due to the proximity to two ranks of high BTU Mexican bituminous coal from the Sabinas and Fuentas basins in Northern Mexico. In all, the infrastructure would allow at least six different sources of coal to be delivered to the Jewett Site.

Lignite could be mined on site. Lignite, other coal ranks, and petroleum coke would be delivered by rail to the Jewett Site. The Burlington Northern Santa Fe railway runs along the property boundary ensuring that fuel can be delivered economically. This line is easily accessible to lines in Mexico, the West Coast, Midwest, Gulf Coast, and East Coast that provide service to entities that are potential sources of fuel and materials to the site. Table 6.16-1 indicates coal and transportation bids for the Jewett Site.

Table 6.16-1. Coal Price Projections

Coal Type	Coal Cost	Rail Transport Cost	Delivered Cost
	Dollars per ton (Dollars per metric ton) of coal		
Powder River Basin	8-9 (8.80-9.90)	13 (14.30)	21-22 (23.10-24.20)
Texas Lignite	10-12 (11-13.20)	3 (3.3)	13-15 (14.30-16.50)
Pennsylvanian	26-28 (28.60-30.8)	7 (7.70)	33-35 (36.30-38.50)
Illinois Basin	27-29 (29.70-31.90)	7 (7.70)	34-36 (37.40-39.60)

All costs in 2005 dollars. Prices projected for the year 2011.
Rail transportation costs were based on mileage estimates to the proposed Odessa Site at an approximately transport costs of 12 cents per ton-mile. Given the reduced distance from the Texas lignite resources to the proposed Jewett Site, the transportation costs for Texas lignite are expected to be somewhat less than indicated.
Source: FG Site Proposal (Jewett, Texas), 2006.

Process Chemical Supply Markets

The process chemicals required by the proposed project are common water treatment and conditioning chemicals that are widely used in industry with broad regional and national availability. Large suppliers of water and waste treatment chemicals in the area include Ciba, Kemira, Nalco, Stockhausen, and the SNF Group.

6.16.2.3 Sulfur Markets

The technologies that would be available for sulfur removal at the proposed power plant are similar to the technologies employed in the petroleum refining industry. These treatment technologies result in the production of elemental sulfur, which is marketable. Texas has a large and mature sulfur production, transportation, and marketing system that can assist in the off-take of sulfur that is produced and treated at the FutureGen site. U.S. production of sulfur was 13.6 million tons (12.3 MMT) in 2002 (TIG, 2002). The sulfur is used in the manufacture of numerous chemical, pharmaceutical, and fertilizer products. Prices in 2005 averaged $51 to $53 per ton in Houston and the current prices are at $60 to $63 per ton in Houston (FG Site Proposal [Jewett, Texas] 2006).

The worldwide supply of sulfur is expected to exceed demand by 5.4 and 5.9 million tons (4.9 and 5.4 MMT) in 2006 and 2011, respectively. The surplus could increase up to 12.1 million tons (11 MMT) in 2011 if clean fuel regulations continue to be implemented worldwide. However, the Sulphur Institute, an international non-profit organization founded by the world's sulfur producers to promote and develop uses for sulfur, sees market potential in developing plant nutrient sulfur products and sulfur construction materials, especially sulfur asphalt. The estimate for the plant nutrient sulfur market is 10.5 million tons (9.5 MMT) annually by 2011. The Sulphur Institute estimates the potential consumption of sulfur in the asphalt industry in North America could reach 0.45 million tons (0.41 MMT) by 2011 (assuming sulfur captures 5 percent of the 30-million-ton [27-million-metric-ton] asphalt market and an average of 30 percent by weight of asphalt replaced by sulfur). Tests on asphalt made with sulfur show it to have a greater resistance to wheel rutting and cracking than conventional asphalt (Morris, 2003).

6.16.2.4 Recycling Facilities

The bottom slag and ash produced by the gasifier would have local and regional markets for reuse. The American Coal Ash Association (ACAA), a non-profit organization that promotes the beneficial use of coal combustion products, reported that 96.6 percent of the bottom slag and up to 42.9 percent of the ash generated by power plants in 2005 was beneficially used rather than disposed of. Primary uses of slag are as blasting grit and as roofing granules, with lesser amounts in structural and asphalt mineral fills. Ash is primarily used in concrete products, structural fills, and road base construction. The ACAA expects the demand for coal combustion products to increase in the next few years. Some of the increase would be due to federal and state transportation departments promoting the use of coal combustion products for road construction (ACAA, 2006).

6.16.2.5 Sanitary Waste Landfills

TCEQ permits landfills receiving nonhazardous waste by type. Type I landfills are sanitary waste landfills and Type IV landfills are construction and demolition debris landfills (30 Texas Administrative Code [TAC] 330.5). TCEQ (30 TAC 330.3 and 30 TAC 330.173) defines nonhazardous industrial waste in three classes, Class 1, 2, and 3, and establishes what landfills are acceptable for disposal of the waste classes as presented below.

- Class 1 waste—Any industrial solid waste or mixture of industrial solid waste that because of its concentration, or physical or chemical characteristics is toxic, corrosive, flammable, a strong sensitizer or irritant, a generator of sudden pressure by decomposition, heat, or other means, or may pose a substantial present or potential danger to human health or the environment when improperly processed, stored, transported, or disposed of or otherwise managed. Waste that is Class 1 only because of asbestos content may be accepted at any Type I landfill that is authorized to accept regulated asbestos-containing material. With approval of the TCEQ Executive Director, Type I and IV landfills can receive Class 1 industrial solid waste and hazardous waste from conditionally exempt small quantity generators, if properly handled and safeguarded in the facility (30 TAC 330.5).
- Class 2 waste—Any individual solid waste or combination of industrial solid waste that are not described as Hazardous, Class 1, or Class 3. Class 2 industrial solid waste, except special waste as defined in §330.3 of this title, may be accepted at any Type I landfill provided the acceptance of this waste does not interfere with facility operation. Type I and Type IV landfills may accept Class 2 industrial solid waste consistent with the established limitations.
- Class 3 waste—Inert and essentially insoluble industrial solid waste, usually including, but not limited to, materials such as rock, brick, glass, dirt, and certain plastics and rubber, etc., that are not readily decomposable. Class 3 industrial solid waste may be disposed of at a Type I or Type IV landfill provided the acceptance of this waste does not interfere with facility operation.

Sanitary waste planning in Texas is the responsibility of 24 Councils of Governments. The Jewett Power Plant Site is located in the Brazos Valley Council of Governments. This area has only one landfill, Rock Prairie Road Landfill, with less than five years remaining capacity in place (Best, 2006). Another landfill has been permitted in Grimes County and should be operational in 2009 (Best, 2006). Landfills located in the Heart of Texas Council of Governments are closer to the proposed site and the remaining disposal capacity in that region is 89 years (TCEQ, 2006b).

Table 6.16-2 lists the sanitary waste landfills in the region and their remaining disposal capacity. Regional landfill capacity in the Jewett area would be available for up to 132 years (based on the disposal capacity for all classes of waste) at current disposal rates. Space on the 400-acre (162-hectare) proposed plant site would be available for a landfill if needed. Figure 6.16-2 shows the location of these facilities in relation to the proposed site in Jewett, Texas.

Table 6.16-2. Nearby Sanitary Waste Landfills

Landfill	Council of Governments	City	Remaining Disposal Capacity in Place (yd^3 [m^3])[1]	Remaining Years of Disposal Capacity[1]	Approximate Distance from Site (miles [km])
Landfills Accepting Classes 2 and 3 Nonhazardous Industrial Waste					
City of Waco Landfill 948A	Heart of Texas	Waco	10,049,250 (7,683,203)	20	63 (101)
Lacy-Lakeview Landfill	Heart of Texas	Waco	2,660,321 (2,033,961)	22	53 (85)
Mexia Landfill	Heart of Texas	Mexia	7,761,832 (5,934,346)	132	18 (29)
Rock Prairie Road Landfill	Brazos Valley	College Station	2,319,310 (1,773,239)	6	85 (137)
Grimes County Landfill	Brazos Valley	Carlos	Permitted, not yet open	30	92 (148)
Landfills Accepting Class 1 Nonhazardous Industrial Waste					
CSC Disposal and Landfill	North Central Texas	Avalon	32,131,976 (24,566,658)	92	67 (108)
Itasca Municipal Solid Waste Landfill	Heart of Texas	Itasca	35,819,409 (27,385,903)	266	77 (124)

[1] Capacity as of September 2005.
yd^3 = cubic yards; m^3 = cubic meters; km = kilometers.
Source: TCEQ, 2006b.

The proposed facility would have the option of disposing of its nonhazardous waste by constructing and operating an on-site landfill, as allowed under the Texas Health and Safety Code. The Texas Health and Safety Code, §361.090, Regulation and Permitting of Certain Industrial Solid Waste Disposal, allows the collection, handling, storage, processing, and disposal of industrial nonhazardous solid waste on site without obtaining a permit or authorization from the TCEQ. A notification to the TCEQ of the on-site waste management activity in accordance with 30 TAC 335.6 and deed recordation in accordance with 30 TAC 335.5 would be required for land disposal of waste.

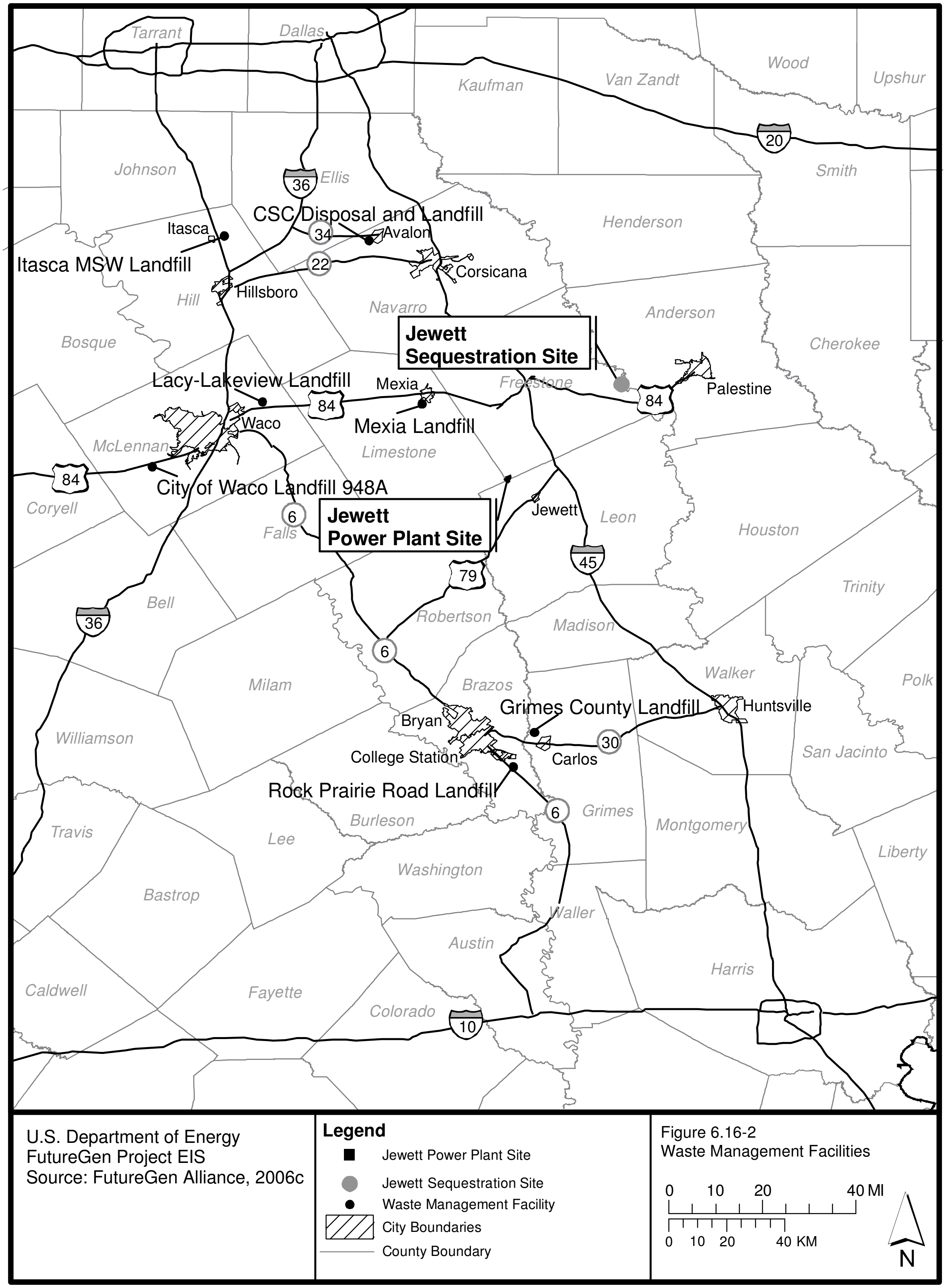

Figure 6.16-2
Waste Management Facilities

6.16.2.6 Hazardous Waste Treatment, Storage, or Disposal Facilities

Two hazardous waste disposal facilities are less than 300 miles (483 kilometers) from the Jewett Site.

- U.S. Ecology Texas, located in Robstown near Corpus Christi, Texas, is approximately 270 miles (435 kilometers) from the proposed power plant site. The facility currently has approximately 140,000 cubic yards (107,038 cubic meters) of remaining capacity with an additional 412,000 cubic yards (314,997 cubic meters) of permitted capacity not yet constructed. A permit modification has been submitted to the TCEQ requesting an additional 2,740,000 cubic yards (2,094,880 cubic meters) of capacity that would replace the current permitted capacity yet to be constructed (FG Alliance, 2006c).
- Chemical Waste Management's Lake Charles Facility, located in Sulphur, Louisiana, is approximately 275 miles (443 kilometers) from the Jewett Site. This facility received 103,621 tons (93,003 metric tons) of hazardous waste in 2003 (EPA, 2003).

6.16.3 IMPACTS

6.16.3.1 Construction Impacts

Power Plant Site

Power plant construction materials would consist primarily of structural steel beams and steel piping, tanks, and valves. Locally obtained materials would include crushed stone, sand, and lumber for the proposed facilities and temporary structures (e.g., enclosures, forms, and scaffolding). Components of the facilities would also include concrete, ductwork, insulation, electrical cable, lighting fixtures, and transformers.

Waste from construction of the proposed facilities would include excess materials, metal scraps, and pallets, crates, and other packing materials. Excess supplies of new materials would be returned to vendors or be retained for future use. Surplus paint and other consumables, partial spools of electrical cable, and similar leftover materials would also be retained for possible future use in maintenance, repairs, and modifications. Scrap metal that could not be reused on site would be sold to scrap dealers. Other scrap materials could also be recycled through commercial vendors. Packaging material (e.g., wooden pallets and crates), support cradles used for shipping large vessels and heavy components, and cardboard and plastic packaging would be collected in dumpsters and periodically transported off site for disposal.

Construction equipment would include cranes, forklifts, air compressors, welding machines, trucks, and trailers. Operation of heavy equipment would require oils, lubricants, and coolants. Should any of these require disposal, they would be special waste or hazardous waste and appropriately managed by the construction contractor.

Petroleum products are sometimes spilled at construction sites as a result of equipment failure (split hydraulic lines, broken fittings) or human error (overfilled tanks). To mitigate the impacts of spills, use of petroleum products, solvents, and other hazardous materials would be restricted to designated areas equipped with spill containment measures appropriate to the hazard and volume of material being stored on the construction site. Refueling, lubrication, and degreasing of vehicles and heavy equipment would take place in restricted areas. An SPCC Plan would be prepared in accordance with 40 CFR 112.7. Personnel would be trained to respond to petroleum and chemical spills and the necessary spill control equipment would be available on site and immediately accessible.

The proposed Jewett Power Plant Site includes up to 200 acres (81 hectares) to allow for the power plant, coal and equipment storage, associated processing facilities, research facilities, the railroad loop surrounding the power plant envelope, and a buffer zone. Debris would be generated as a result of clearing and grading. Only about 60 acres (24 hectares) of the site would be required for the facilities comprising the power plant footprint (see Figure 2-18). Any excavated material could be used as fill on the site. This debris would be disposed on site or transported to an off-site landfill for disposal.

The waste requiring disposal could be disposed of on site, if an on-site landfill was developed, or at permitted off-site landfills. Ample room would be available for an on-site solid waste landfill.

Area sanitary landfills would have ample capacity to receive project construction waste. Because the quantity of waste from project construction would be small in comparison with the landfill capacity and waste quantities routinely handled, disposal of this waste would not be expected to have an impact.

Sequestration Site

The proposed sequestration site is located 33 miles (53 kilometers) away from the Jewett Power Plant Site. The components to be constructed at the sequestration site would include injection wells, four production wells, associated piping, and an access road (road construction is discussed below.). CO_2 would be injected into two target reservoirs (Woodbine [two wells] and Travis Peak [one well]) at slightly different pressures. A recompression pump would be needed to increase the pressure of the CO_2 that would be injected into the deeper formation. The materials needed are piping and concrete for seaming. Sources for these construction materials are well established nationally; none of the quantities of materials required would create demand or supply impacts.

The materials would be ordered in the correct sizes and number, resulting in small amounts of excess material that could be saved for use on a different project and very small amounts of waste to be disposed in a permitted landfill accepting construction debris. Heavy equipment would be used that require fuel, oils, lubricants, and coolants. Should any of these require disposal, they would be special waste or hazardous waste and appropriately managed by the construction contractor. Precautions would be taken to mitigate the impacts of petroleum and chemical spills and personnel would be trained and equipped to respond to spills when they occur. Solid and hazardous waste disposal capacity in the region is detailed in Table 6.16-2 and Section 6.16.2.6. There would be no impact to waste collection services or disposal capacity.

Utility Corridors

The following utility infrastructure would be constructed to support the proposed FutureGen facility:

- New electric transmission substation (an option involving up to 2 miles (3.2 kilometers) of transmission line in new ROW is also being evaluated).
- 2,000-foot (610-meter) long water pipeline on site serving both process water and potable water needs.
- On-site wastewater treatment facility.
- Options involving 43 to 53 miles (69.2 to 85.3 kilometers) of CO_2 pipeline using existing ROW and 6 to 9 miles (10 to 14 kilometers) of new ROW are being evaluated.

Where utilities would be placed along existing utility corridors minimal clearing of vegetation and grading, creating land clearing debris may require removal and disposal. New ROW may require more extensive land clearing and grading. However, construction debris disposal capacity would be available at area landfills or at an on-site landfill, if developed.

The construction of the pipelines, transmission lines, transmission substation, and wastewater treatment system would require pipe, joining and welding materials including compressed gases, steel cable and structures, and insulated wiring for transmission lines, and building construction materials such as lumber and masonry materials. Sources for these construction materials are well established nationally; and the quantities of materials required to construct the infrastructure would not create demand or supply impacts.

Construction materials would be ordered in the correct sizes and number, resulting in small amounts of excess material that could be saved for use on a different project and very small amounts of waste to be disposed in a permitted landfill accepting construction debris. Heavy equipment would be used that require fuel, oils, lubricants, and coolants. Should any of these require disposal, they would be special waste or hazardous waste and appropriately managed by the construction contractor. Precautions would be taken to mitigate the impacts of petroleum and chemical spills and personnel would be trained and equipped to respond to spills when they occur. Solid and hazardous waste disposal capacity in the region is detailed in Table 6.16-2 and Section 6.16.2.6. There would be no impact to waste collection services or disposal capacity.

Transportation Corridors

Roads

The proposed Jewett Power Plant Site is served by a road system that is adequate for the site and no upgrades as planned (FG Alliance, 2006c). The FutureGen contractor would be responsible for constructing on-site roads.

The materials needed for on-site road construction are concrete, aggregate, and asphalt. Road construction results in minimal waste due to the ability to recycle and reuse these materials. Excavated soil would be used for fill elsewhere along the route and asphalt would be recycled. Road construction would require heavy equipment that would need fuel, oils, lubricants, and coolants. Should any of these require disposal, they would be special waste or hazardous waste and appropriately managed by the construction contractor. Precautions would be taken to mitigate the impacts of petroleum and chemical spills and personnel would be trained and equipped to respond to spills when they occur. Solid and hazardous waste disposal capacity in the region is detailed in Table 6.16-2 and Section 6.16.2.6. There would be no impact to waste collection services or disposal capacity.

Rail

The proposed power plant site has rail access that would require the construction of an on-site rail loop. The materials needed for construction of an industrial rail siding and loop track would be steel for rails and pre-cast concrete railbed ties, and rock for ballast. The sources for rails and railbed ties are well established nationally; none of the quantities of materials required for constructing a rail spur would create demand or supply impacts. Furthermore, these materials would be ordered in the correct sizes and number, resulting in small amounts of excess material that could be saved for use on a different project and very small amounts of waste to be disposed in a permitted landfill accepting construction debris.

In addition, to the materials to be installed, construction of the rail loop would require fuel, oils, lubricants, and coolants for heavy machinery, and compressed gasses for welding. Should any of these require disposal, they would be special waste or hazardous waste and shipped to permitted hazardous waste treatment and disposal facility. Precautions would be taken to mitigate the impacts of petroleum and chemical spills and personnel would be trained and equipped to respond to spills when they occur.

Solid and hazardous waste disposal capacity in the region is detailed in Table 6.16-2 and Section 6.16.2.6. There would be no impact to waste collection services or disposal capacity.

6.16.3.2 Operational Impacts

Power Plant Site

The FutureGen Project would be capable of using various coals. The proposed Jewett Power Plant Site sits in the middle of a vast belt of lignite coal that stretches from Louisiana, across Texas, and into northern Mexico. The site itself sets atop of a lignite mine. For purposes of analysis, the following coals were evaluated:

- Northern Appalachian Pittsburgh seam;
- Illinois Basin from the states of Illinois, Indiana, and Kentucky; and
- PRB from Wyoming.

Coal consumption would vary depending on the gasification technology and type of coal. Table 6.16-3 provides the range of values based on the conceptual design for the FutureGen facility. The Case 3B option is a smaller, side-stream power train that would enable more research and development activities than the main train of the power plant. To estimate the operating parameters for analysis of impacts in this EIS, DOE assumed this smaller system could be paired with any of the other designs under consideration. For these fuel types, the maximum coal consumption rate would be approximately 254 tons (230 metric tons) per hour (FG Alliance, 2007) or up to 1.89 million tons (1.71 MMT) per year based on 85 percent availability (FG Alliance, 2006e). This represents 1.9 percent of the 101 million tons (91.6 MMT) of coal of all types consumed by electric utilities within the state in 2005 (EIA, 2006). Coal would be delivered to the proposed Jewett power plant site by rail and stored in two coal piles, each providing storage capacity for approximately 15 days of operation (FG Alliance, 2006e). If required, run-off from the coal storage areas would be collected and treated in the plant's zero liquid discharge (ZLD) wastewater treatment system.

Table 6.16-3. Coal Consumption

Coal Gasification Technology	Type of Coal (pounds [kilograms] per hour)		
	Pittsburgh	Illinois Basin	Powder River Basin
Case 1	224,745 (101,943)	248,370 (112,659)	281,167 (127,535)
Case 2	213,287 (96,745)	244,153(110,746)	353,809 (160,485)
Case 3A	208,425 (94,540)	238,577 (108,217)	342,790 (155,487)
Case 3B (optional)[1]	97,625 (44.282)	111,791 (50,708)	154,349 (70,012)

[1]Case 3B is an optional add-on to the other technology cases (1, 2, 3A) but is considered unlikely to be implemented.
Source: FG Alliance, 2007.

The estimated consumption of process chemicals by the proposed power plant is presented in Table 6.16-4. The table also provides the estimated on-site storage requirements assuming a 30-day chemical supply would be maintained at the power plant site. Potential impacts from storage of the chemicals are discussed in Section 6.17. These chemicals are commonly used in industrial facilities and widely available from national suppliers. The materials needed in the largest quantities are for sulfuric acid, sodium hypochlorite, and lime. The polymer and antiscalants and stabilizers needed for the cooling tower, makeup water, and wastewater systems are not specified and a variety of products are available from national suppliers. A large producer of water treatment specialty chemicals is Ciba (Ciba, 2006).

Table 6.16-4. Process Chemicals Consumption and Storage

Chemical	Annual Consumption (tons [metric tons])	Estimated Storage On Site (gallons [liters])
Selective Catalytic Reduction (NO_x emission control)		
Aqueous Ammonia (19 percent)	1,333 (1,209)	28,700 (108,641)
Cooling Tower		
Sulfuric Acid (98 percent)	8,685 (7,879)	94,200 (356,586)
Antiscalant	0.47 (0.42)	8 (30)
Sodium Hypochlorite	1,684 (1,527)	32,900 (124,540)
Make-up Water and Wastewater Treatment Demineralizers		
Sodium Bisulfite	12 (10.9)	155 (587)
Sulfuric Acid	106 (95.8)	1,150 (4,353)
Liquid Antiscalant & Stabilizer	27 (24.5)	443 (1,677)
Clarifier Water Treatment		
Lime	1,237 (1,122)	7,380 (27,963)
Polymer	295 (268)	5,020 (19,003)
Acid Gas Removal		
Physical Solvent	11,300 gallons (42,775 liters)	940 (3,588)

Source: FG Alliance, 2007.

The coal gasification process would annually consume approximately 8,790 tons (7,974 metric tons) of sulfuric acid, 1,680 tons (1,524 metric tons) of sodium hypochlorite, and 1,240 tons (1,125 metric tons) of lime. As discussed in Section 6.16.2.3, the sulfur market is expected to have a surplus for the next few years as production increases, so additional demand would not adversely impact the sulfur market. Sodium hypochlorite has producers located across the U.S. including Illinois, Indiana, Michigan, and Missouri. The U.S. sodium hypochlorite production capacity is vastly underused. Industrial sodium hypochlorite production capacity is estimated at 1.55 billion gallons (5.87 billion liters) per year (TIG, 2003). The current (2006) demand is projected to be 292 million gallons (1.1 billion liters), less than 20 percent of the production capacity (TIG, 2003). Worldwide production of lime was 141 million tons (128 MMT) in 2005, with the U.S. producing 22 million tons (20 MMT) (USGS, 2006a). Chemical Lime, one of the ten largest lime producers in the U.S., operates plants in Texas, including nearby Bosque County (USGS, 2006b). Given that the chemicals required to operate the FutureGen facility are common industrial chemicals that are widely available and produced in large quantities in the U.S., the chemical consumption impact would be minimal.

The by-products generated by the proposed power plant would be sulfur bottom slag, and ash. As previously discussed, there are established markets and demand for these materials.

Sulfur production would depend on the gasification technology and the type of coal used. The maximum amount of sulfur generated would be 133 tons (121 metric tons) per day (FG Alliance, 2007) for an annual maximum of 41,232 tons (37,406 metric tons) based on 85 percent availability. The U.S. production of sulfur in 2002 was 13.6 million tons (12.4 MMT). The maximum potential FutureGen sulfur production represents 0.30 percent of the U.S. production. Supply of sulfur exceeds demand; however, new uses of sulfur are being promoted by sulfur producers that should help balance supply and demand of sulfur. The worldwide supply was estimated to exceed demand by up to 12.1 million tons (11 MMT) in 2011 without the development of new markets. The FutureGen maximum production would increase this surplus by less than 0.34 percent.

As previously noted, operation of the FutureGen Project would require a source of sulfuric acid. Assuming a complete conversion to sulfuric acid, the sulfur produced by the facility would be sufficient to generate about 126,000 tons (114,305 metric tons) per year of sulfuric acid. This would be sufficient to meet the demand for sulfuric acid at the power plant site.

The FutureGen facility would generate an estimated 96,865 tons (87,875 metric tons) of bottom slag or ash annually based on the three primary technology cases (1, 2, and 3A) (FG Alliance, 2007). If Case 3B were implemented, the amount of slag or ash would increase by approximately 49 percent over the base case. Nearly all of the bottom slag (96.6 percent) produced in the U.S. enters the market and is beneficially used, and the availability of bottom slag is expected to decrease (ACAA, 2006). Based on the 2006 statistics from the ACAA for beneficial use of slag, 3.4 percent of the bottom slag that would be generated annually would be disposed as waste (see Table 6.16-5). Further characterization would be necessary to determine whether the quality of the slag produced by the proposed power plant would support this level of reuse. Based on the average of the ACAA (2006) statistics for bottom ash and fly ash, 58.1 percent of the ash that would be generated annually would be disposed as waste (see Table 6.16-5). The recycled bottom slag and ash produced by the proposed power plant is not expected to have an adverse impact on the market with the supply being expected to be equal or less than the demand.

Much of the industrial waste generated by FutureGen would likely be Class 2 or 3 and eligible for disposal in Type 1 municipal solid waste landfills. Other waste generated by FutureGen such as environmental controls waste (e.g., clarifier sludge) could potentially be classified as a Class 1 industrial waste and would be eligible for disposal in Type 1 municipal landfills that are approved for Class 1 industrial waste disposal by TCEQ. Table 6.16-2 lists the area landfills and their disposal capabilities. The estimated waste generation for the Jewett Power Plant is presented in Table 6.16-5. In addition to the waste listed in Table 6.16-5, the FutureGen facility may generate small amounts of hazardous waste such as solvents and paints from maintenance activities.

Table 6.16-5. Waste Generation

Waste	Annual Quantity (tons [metric tons])	Classification
Unrecycled bottom slag (Cases 1, 2, 3B)	3,290 (2,985) [1]	Special waste (Coal combustion product)
Unrecycled ash (if non-slagging gasifiers are used)	56,280 (51,056)[2]	Special waste (Coal combustion byproduct)
ZLD (wastewater system) clarifier sludge	1,545 (1,402)	Special waste
ZLD filter cake	5,558 (5,042)	Special waste
Sanitary solid waste (office and break room waste)[3]	336 (305)	Municipal solid waste

[1] Based on ACAA (2006) statistics, DOE assumed that all but 3.4 percent of total slag production would be recycled rather than disposed of. If Case 3B were implemented, quantities would increase by 49 percent.
[2] Based on ACAA (2006) statistics, DOE assumed that 41.9 percent of total ash production would be recycled rather than disposed of. If Case 3B were implemented, quantities would increase by 49 percent.
[3]Quantity estimated for 200 employees using an industrial waste generation rate of 9.2 pounds (4.2 kilograms) per day per employee (CIWMB, 2006).
Source: FG Alliance, 2007, except as noted.

Chemical waste would be generated by periodic cleaning of the heat recovery steam generator and turbines. This waste would consist of alkaline and acidic cleaning solutions and wash water. They are likely to contain high concentrations of heavy metals. Chemical cleaning would be performed by outside contractors who would be responsible for the removal of associated waste products from the site. Precautions would be taken to prevent releases by providing spill containment for tankers used to store cleaning solutions and waste.

Other waste would include solids generated by water and wastewater treatment systems, such as activated carbon used in sour water treatment. Sulfur-impregnated activated carbon would be used to remove mercury from the synthesis gas. This mercury sorbent would be replaced periodically and the spent carbon would likely be hazardous waste. The spent carbon would be regenerated and reused at the site. It could also be returned to the manufacturer for treatment and recycling or transferred to an off-site hazardous waste treatment facility. Used oils and used oil filters would be collected and transported off site by a contractor for recycling or disposal.

The FutureGen facility would have the option of disposing of its nonhazardous waste in an on-site landfill, if one was developed. In addition, the operator could dispose of its industrial waste streams (Class 2 and 3) in a municipal landfill. Class 1 nonhazardous industrial waste could be disposed at area municipal landfills accepting that waste. TCEQ concluded that the Heart of Texas Council of Governments region (the 6-county region adjacent to Leon County) had 89 years of remaining landfill capacity at the 2005 rate of disposal (TCEQ, 2006b). Capacity at hazardous waste landfills is also substantial. The closest hazardous waste landfill has remaining capacity of over 500,000 cubic yards (380,000 cubic meters) and is pursuing a permit to increase that capacity by more than 2 million cubic yards (1.5 million cubic meters). Given the sanitary and hazardous waste disposal capacities available in the region, the impact of disposal of FutureGen-generated waste would be minimal. Given the small amount of hazardous waste (e.g., paints and solvents) that would be generated and the availability of commercial treatment and disposal facilities, the on-site waste management activities are not expected to require a RCRA permit.

Sequestration Site

During normal operations, the sequestration site components would generate minimal waste due to routine maintenance and workers presence. The waste could be special/hazardous (e.g., lubricants and oils), industrial waste (e.g., old equipment), and sanitary waste (e.g., packaging and lunch waste). The minimal waste quantities would not impact disposal capacities of area landfills and waste collection services.

Several pre-injection hydrologic tests would be performed during site characterization to establish the hydrologic storage characteristics and identify the general permeability characteristics at the sequestration site. The following water-soluble tracers may be used:

- Potassium bromide (as much as 220 lb [100 kg])
- Fluorescein (as much as 132 lb [60 kg])
- 2,2-dimethyl-3-pentanol (as much as 4.4 lb [2.0 kg])
- Pentafluorobenzoic acid (as much as 8.8 lb [4.0 kg])

A suite of gas-phase tracers would be co-injected with the CO_2 to improve detection limits for monitoring. The tracers expected to be used include:

- Perfluoromethylcyclopentane (as much as 330 lb [150 kg])
- Perfluoromethylcyclohexane (as much as 2,646 lb [1,200 kg])

- Perfluorodimethylcyclohexane (as much as 330 lb [150 kg])
- Perfluorotrimethylcyclohexane (as much as 2,646 lb [1,200 kg])
- Sulfur hexafluoride (SF_6) (as much as 66 lb [30 kg])
- Helium-3 (^3He) (as much as 0.033 lb [15 g])
- Krypton-78 (^{78}Kr) (as much as 0.44 lb [200 g])
- Xenon-124 (^{124}Xe) (as much as 0.088 lb [40 g])

The last three are stable, non-radioactive, isotope noble gas tracers. Tracers are a key aspect of the planned monitoring activities for the FutureGen sequestration site. The tracers would 1) contact the CO_2, water, and minerals, 2) limit the problem of interference from naturally occurring CO_2 background concentrations, and 3) provide a statistically superior monitoring and characterization method because of the redundancy built in by using multiple tracers. Tracers would be purchased in the required amounts and would be consumed (injected into the subsurface) as a result of the site characterization and monitoring activities.

Utility Corridors

During normal operations, the utility corridors and pipelines would not require additional materials and would not generate waste other than cleared vegetation, if necessary, that could be disposed of at a non-hazardous waste landfill.

Transportation Corridors

Roads

On-site roads would require periodic re-surfacing at a frequency dependent on the level of use and weathering. Asphalt removed from the road surface would be recycled. Road re-surfacing would involve heavy equipment that would require oils, lubricants, and coolants. Should any of these require disposal, they would be special waste or hazardous waste and appropriately managed by the construction contractor.

Rail

Maintenance of the rail loop would consist of replacing the rails and equipment at a frequency dependent on the level of use and weathering. Replacement materials would be obtained in the correct sizes and quantities from established suppliers and the small amount of waste remaining after materials are reused or recycled would be disposed of in a permitted facility. Any special or hazardous waste (e.g., oils and coolants) generated during rail replacement would be managed by the contractor.

6.17 HUMAN HEALTH, SAFETY, AND ACCIDENTS

6.17.1 INTRODUCTION

This section describes the potential human health and safety impacts associated with the construction and operation of the proposed project. The health and safety impacts are evaluated in terms of the potential risk to both workers and the general public. The level of risk is estimated based on the current conceptual design of the proposed project, applicable health and safety and spill prevention regulations, and expected operating procedures.

Federal, state, and local health and safety regulations would govern work activities during construction and operation of the proposed project. Additionally, industrial codes and standards also apply to the health and safety of workers and the general public.

6.17.1.1 Region of Influence

The ROI for human health, safety, and accidents is the area within 10 miles (16.1 kilometers) of the boundaries of the proposed power plant site, sequestration site, and CO_2 pipeline. At the proposed Jewett Sequestration Site, modeling of the deep saline formation with an injection rate of 2.8 million tons (2.5 MMT) per year for 20 years produced a CO_2 plume radius of 1.7 miles (2.7 kilometers) (FG Alliance, 2006c). Because this is a first of its kind research project, 10 miles (16.1 kilometers) was chosen as a conservative distance in terms of the ROI for the proposed sequestration site.

6.17.1.2 Method of Analysis

DOE performed analyses to evaluate the potential effects of the proposed power plant and sequestration activities on human health safety, and accidents. The potential for occupational or public health impacts was based on the following criteria:

- Occupational health risk due to accidents, injuries, or illnesses during construction and normal operating conditions;
- Health risks (hazard quotient or cancer risk) due to air emissions from the proposed power plant under normal operating conditions;
- Health risks due to unintentional releases associated with carbon sequestration activities; and
- Health risks due to terrorist attack or sabotage at the proposed power plant or carbon sequestration site.

Potential occupational safety impacts were estimated based on national workplace injury, illness, and fatality rates. These rates were obtained from the U.S. Bureau of Labor Statistics (USBLS) and are based on similar industry sectors. The rates were applied to the anticipated numbers of employees for each phase of the proposed project. From these data, the projected numbers of Total Recordable Cases (TRCs), lost work day (LWD) cases, and fatalities were calculated. These analyses are presented in Section 6.17.2.

The calculated cancer risks and hazard quotients for the air emissions under normal operating conditions are summarized in Section 6.17.3.1. Potential hazards from the accidental release of toxic/flammable gas for different plant components were evaluated by Quest (2006). This study addressed failure modes within the proposed plant boundary and was performed to identify any systems or individual process unit components that would produce a significantly larger potential for on-site or off-site impact based on different plant configurations. The results are summarized in Section 6.17.3.2.

Potential health effects were evaluated for workers and the general public who may be exposed to releases of captured gases (CO_2 and H_2S) during pre- and post-sequestration conditions. Gas releases were evaluated at the proposed plant, during transport via pipeline, at the sequestration site, and during subsurface storage (Tetra Tech, 2007). The results of these risk analyses are summarized in Section 6.17.4.

The potential impacts from a terrorism or sabotage event were determined by examining the results of the accident analysis of major and minor system failures or accidents at the proposed plant site and gas releases along the CO_2 pipeline(s) and at injection wells. The results of this analysis are provided in Section 6.17.5.

6.17.2 OCCUPATIONAL HEALTH AND SAFETY

6.17.2.1 Typical Power Plant Health and Safety Factors and Statistics

Power Plant Construction

Table 6.17-1 shows the injury/illness and fatality rates for the most recent year (2005) utility related construction. These rates are expressed in terms of injury/illness per 100 worker-years (or 200,000 hours) for TRCs, LWDs, and fatalities.

Power Plant Operation

Because of the gasification and chemical conversion aspects of the proposed power plant, it would operate more like a petrochemical facility rather than a conventional power plant. As a result, occupational injury/illness rates for the petrochemical manufacturing sector were used in the analysis of the proposed power plant operation (Table 6.17-1). These rates are presented for TRCs, LWDs, and fatality rates.

Table 6.17-1. Occupational Injury/Illness and Fatality Data for Project Related Industries in 2005

Industry	2005 Average Annual Employment (thousands)[1]	Total Recordable Case Rate (per 100 workers)[1]	Lost Workday Cases (per 100 workers)[1]	Fatality Rate (per 100 workers)[2]
Utility system construction	388.2	5.6	3.2	0.028
Petrochemical Manufacturing	29.2	0.9	0.4	0.001
Electric power transmission, control, and distribution	160.5	5.1	2.4	0.0062
Natural Gas Distribution	107.0	5.9	3.2	0.0025

[1]Source: USBLS, 2006a.
[2]Source: USBLS, 2006b.

Transmission Lines and Electro-Magnetic Fields

Magnetic fields are induced by the movement of electrons in a wire (current); and electric fields are created by voltage, the force that drives the electrical current. All electrical wiring, devices, and equipment, including transformers, switchyards, and transmission lines, produce electromagnetic fields (EMF). The strength of these fields diminishes rapidly with distance from the source. Building material, insulation, trees, and other obstructions can reduce electric fields, but do not significantly reduce magnetic fields. Electrical field strength is measured in kilovolts per meter, or kV/m. Magnetic field strength is expressed as a unit of magnetic induction (Gauss) and is normally expressed as a milligauss (mG), which is one thousandth of a Gauss. The average residential electric appliance typically has an electrical field of less than 0.003 kV/ft (0.01 kV/m). In most residences, when in a room away from electrical appliances, the magnetic field is typically less than 2 mG. However, very close to an appliance carrying a high current, the magnetic field can be thousands of milligauss.

Electric fields from power lines are relatively stable because line voltage does not vary much. However, magnetic fields on most lines fluctuate greatly as current changes in response to changing loads (consumption or demand).

Transmission lines contribute a relatively small portion of the electric and magnetic fields to which people are exposed. Nonetheless, over the past two decades, some members of the scientific community and the public have expressed concern regarding human health effects from EMF during the transmission of electrical current from power plants. The scientific evidence suggesting that EMF exposures pose a health risk is weak. The strongest evidence for health effects comes from observations of human populations with two forms of cancer: childhood leukemia and chronic lymphocytic leukemia in occupationally exposed adults (NIEHS, 1999). The National Institute of Environmental Health Sciences report concluded that, "extremely low-frequency and magnetic field exposure cannot be recognized as entirely safe because of weak scientific evidence that exposure may pose a leukemia hazard" (NIEHS, 1999). While a fair amount of uncertainty still exists about the EMF health effects issue, the following determinations have been established from the information:

- Any exposure-related health risk to an individual would likely be small;
- The types of exposures that are most biologically significant have not been established;
- Most health concerns relate to magnetic fields; and
- Measures employed for EMF reduction can affect line safety, reliability, efficiency, and maintainability, depending on the type and extent of such measures.

CO_2 and Natural Gas Pipeline Safety

More than 1,500 miles (2,414 kilometers) of high-pressure long distance CO_2 pipelines exist in the U.S (Gale and Davison, 2004). In addition, numerous parallels exist between CO_2 and natural gas transport. Most rules and regulations written for natural gas transport by pipeline include CO_2. These regulations are administered and enforced by DOT's Office of Pipeline Safety (OPS). States also may regulate pipelines under partnership agreements with the OPS. The rules are designed to protect the public and the environment by ensuring safety in pipeline design, construction, testing, operation, and maintenance. Risks associated with pipeline activities are determined to be low (IOGCC, 2005). However, in pipelines that carry captured CO_2 for sequestration, other gases may be captured and transported as well, and could affect risks posed to human health and the environment. For the proposed FutureGen Project, the captured gases might contain up to 100 parts per million by volume (ppmv) of H_2S in the pipeline on a routine basis, and should any of the captured gases escape to the environment, risks from exposure to H_2S would have to be estimated, as well as risks from CO_2 exposure.

Table 6.17-1 shows the occupational injury/illness and fatality rates for 2005 for operation of natural gas distribution systems. These rates are expressed in terms of injury/illness rate per 100 workers (or

200,000 hours) for TRCs, LWDs, and fatality rates. These rates are used to indicate occupational injuries associated with pipelines, although the properties and types of hazards of natural gas are different from those of CO_2. Because natural gas is highly flammable, these rate are determined to be conservative in relation to CO_2 pipelines.

6.17.2.2 Impacts

This subsection describes potential occupational health and safety risks associated with construction and operation of the proposed project. Features inherent in the design of project facilities as well as compliance with mandatory regulations, plans, and policies to reduce these potential risks are summarized within each risk category.

Construction

Power Plant Site

Potential occupational health and safety risks during construction of the proposed power plant and facilities are expected to be typical of the risks for major industrial/commercial construction sites. Health and safety concerns include: the movement of heavy objects, including construction equipment; slips, trips, and falls; the risk of fire or explosion from general construction activities (e.g., welding); and spills and exposures related to the storage and handling of chemicals and disposal of hazardous waste.

Risk of Fire or Explosion from General Construction Activities

Contractors experienced with the construction of coal and gas-fired electricity generating plants and refineries would be used on the proposed project. Construction specifications would require that contractors prepare and implement construction health and safety programs that are intended to control worker activities as well as establish procedures to prevent and respond to possible fires or explosions. The probability of a significant fire or explosion during construction of the proposed project has been determined to be low. With implementation of BMPs and procedures described in the following paragraphs, health and safety risks to construction workers and the public would also be low.

During construction, small quantities of flammable liquids and compressed gases would be used and stored on site. Liquids would include construction equipment fuels, paints, and cleaning solvents. Compressed gases would include argon, acetylene, helium, nitrogen, and O_2 for welding. Potential risk hazards associated with the use of flammable liquids and compressed gases would be reduced by compliance with a construction health and safety program and proper storage of these materials when not in use, in accordance with all applicable federal, state, and local regulations. The construction health and safety program would include the following major elements:

- An injury and illness prevention program;
- A written safety program (including hazard communication);
- A personnel protection devices program; and
- On-site fire suppression and prevention plans.

Storage and Handling of Hazardous Materials, Fuels, and Oils

Hazardous materials used during construction would be limited to gasoline, diesel fuel, motor oil, hydraulic fluid, solvents, cleaners, sealants, welding flux and gases, various lubricants, paint, and paint thinner. Small quantities of materials would be stored in a flammable storage locker, and drums and tanks would be stored in a secondary containment. Storage of the various types of chemicals would conform to Occupational Safety and Health Administration (OSHA) and applicable state guidelines. Construction personnel would be trained in handling chemicals, and would be alerted to the dangers associated with the storage of chemicals. An on-site Environmental Health and Safety Representative would be designated to implement the construction health and safety program and to contact emergency response personnel and the local hospital, if necessary. MSDS for each chemical would be kept on site, and construction employees would be made aware of their location and content.

To limit exposure to uncontrolled releases of hazardous materials and ensure their safe handling, specific procedures would be implemented during construction, including:

- Lubrication oil used in construction equipment would be contained in labeled containers. The containers would be stored in a secondary containment area to collect any spillage.
- Vehicle refueling would occur at a designated area and would be closely supervised to avoid leaks or releases. To further reduce the possibility of spills, no topping-off of fuel tanks would be allowed.
- If fuel tanks are used during construction, the fuel tank(s) would be located within a secondary containment with an oil-proof liner sized to contain the single largest tank volume plus an adequate space allowance for rainwater. Other petroleum products would be stored in clearly labeled and sealed containers or tanks.
- Construction equipment would be monitored for leaks and undergo regular maintenance to ensure proper operation and reduce the chance of leaks. Maintenance of on-site vehicles would occur in a designated location.
- All paint containers would be sealed and properly stored to prevent leaks or spills. Unused paints would be disposed of in accordance with applicable state and local regulations.

Overall, BMPs would be employed that would include good housekeeping measures, inspections, containment maintenance, and worker education.

Spill Response and Release Reporting

Small quantities of fuel, oil, and grease may leak from construction equipment. Such leakage should not be a risk to health and safety or the environment because of low relative toxicity and low concentrations. If a large spill from a service or refueling truck were to occur, a licensed, qualified waste contractor would place contaminated soil in barrels or trucks for off-site disposal.

The general contractor's responsibility would include implementation of spill control measures and training of all construction personnel and subcontractors in spill avoidance. Training would also include appropriate response when spills occur, and containment, cleanup, and reporting procedures consistent with applicable regulations. The primary plan to be developed would describe spill response and cleanup procedures. In general, the construction contractor would be the generator of waste oil and miscellaneous hazardous waste generated during construction and would be responsible for compliance with applicable federal, state, and local laws, ordinances, regulations, and standards. This would include licensing, personnel training, accumulation limits, reporting requirements, and record keeping.

During construction, the potential exists for a major leak during the chemical cleaning of equipment or piping before it is placed into service. This method of cleaning could consist of an alkaline degreasing step (in which a surfactant, caustic, or NH_3 solution is used), an acid cleaning step, and a passivation step. Most of the solution would be contained in permanent facility piping and equipment. The components of the process that would be most likely to leak are the temporary chemical cleaning hoses, pipes, pump skids, and transport trailers. The cleaning would be within curbed areas, and spills would be manually cleaned up and contaminated materials disposed of in accordance with the applicable regulations.

Due to the limited quantities and types of hazardous materials used during construction, the likelihood of a spill reaching or affecting off-site residents would be low.

Medical Emergencies during Construction

Selected construction personnel would receive first aid and CPR training. On-site treatment would be provided in medical situations that require only first aid or stabilization of the victim(s) until professional medical attention could be attained. Any injury or illness that would require treatment beyond first aid would be referred to the local hospital.

Worker Protection Plan

The construction contractor would develop, implement, and maintain a Worker Protection Plan. This plan would implement OSHA requirements (1910 and 1926) and would define policies, procedures, and practices implemented during the construction process to ensure protection of the workforce, environment, and the public. The minimum requirements addressed by the Worker Protection Plan would include:

- Environment, Safety, and Health Compliance
- Working Surfaces
- Scaffolding
- Powered Platforms, Manlifts, and Vehicle-Mounted Platforms
- Fall Protection
- Cranes, Derricks, Hoists, Elevators, and Conveyors
- Hearing Conservation
- Flammable and Combustible Liquids
- Hazardous Waste Operations
- Personal Protective Equipment
- Respiratory Protection
- Confined Space Program
- Hazardous Energy Control
- Medical and First Aid
- Fire Protection
- Compressed Gas Cylinders
- Materials Handling and Storage
- Hand and Portable Powered Tools
- Welding, Cutting and Brazing
- Electrical Safety
- Toxic and Hazardous Substances
- Hazardous Communications
- Heat Stress

Industrial Safety Impacts

Based on data for the construction of similar projects, the construction workforce would average about 350 employees, with a peak of about 700 during the most active period of construction. Since the nature of the activities to be performed across all areas of the proposed project would be similar in scope, industrial safety impacts were calculated for the proposed project and not for each construction sector. Based on the employment numbers during the construction phase, the TRCs, LWDs, and fatalities presented in Table 6.17-2 would be expected. As shown in Table 6.17-2, based on the estimated number of workers during construction, no fatalities would be expected (calculated number of fatalities is less than one).

Table 6.17-2. Calculated Annual Occupational Injury/Illness and Fatality Cases for Power Plant Construction

Construction Phase	Number of Employees	Total Recordable Cases	Lost Work Day Cases	Fatalities
Average	350	20	11	0.098
Peak	700	39	22	0.196

Sequestration Site

Accidents are inherently possible with any field or industrial activities. Well drilling can lead to worker injuries due to: being struck with or pinned by flying or falling parts and equipment; trips and falls; cuts, bruises, and scrapes; exposure to high noise; and muscle strains due to overexertion. Catastrophic accidents could involve well blowouts, derrick collapse, exposure to hydrogen sulfide and other hazardous gases, fire, or explosion. Although catastrophic accidents frequently involve loss of life as well as major destruction of equipment, they represent only a small percentage of the total well drilling occupational injury incidence and severity rates. Most well drilling injuries (60 to 70 percent) were reported by workers with less than six months of experience (NIOSH, 1983). To avoid well drilling accidents, a worker protection plan and safety training (particularly for new workers) would be instituted, covering all facets of drilling site safety.

Utility Corridors

Risks and hazards associated with construction of power lines, substations, and pipelines would be addressed through the Worker Protection Plan. Many of these types of construction activities may be undertaken by public utilities or companies specializing in this type of work and would be governed by their worker protection programs.

Transportation Infrastructure Corridors

Risks and hazards associated with construction activities for access roads, public road upgrades, and the rail loop would be addressed through the Worker Protection Plan. Construction activities on public roads may be undertaken by city or county public works departments and would be governed by their worker protection programs.

Operational Impacts

Two categories of accidents could occur that would pose an occupational health and safety risk to individuals at the proposed power plant, on the CO_2 pipeline, at the CO_2 sequestration site, or in the proposed project vicinity; risk of fire or explosion either from general facility operations or specifically from a gas release (e.g., syngas, hydrogen, natural gas, H_2S, or CO_2); and risk of a hazardous chemical release or spill. Risk assessments evaluating accidents (e.g., explosions and releases) were performed to evaluate potential impacts for both workers and the public. The results of these assessments are summarized in Sections 6.17.3.2 and 6.17.4.

Power Plant Site

The operation of any industrial facility or power plant holds the potential for workplace hazards and accidents. To promote the safe and healthful operation of the proposed power plant, qualified personnel would be employed and written safety procedures would be implemented. These procedures would provide clear instructions for safely conducting activities involved in the initial startup, normal operations, temporary operations, normal shutdowns, emergency shutdowns, and subsequent restarts. The procedures for emergency shutdowns would include the conditions under which such shutdowns are required and the assignment of emergency responsibilities to qualified operators to ensure that procedures are completed in a safe and timely manner. Also covered in the procedures would be the consequences of operational deviations and the steps required to correct or avoid such deviations. Employees would be given a facility plan, including a health and safety plan, and would receive training regarding the operating procedures and other requirements for safe operation of the proposed power plant. In addition, employees would receive annual refresher training, which would include the testing of their understanding of the procedures. The operator would maintain training and testing records.

The proposed power plant would be designed to provide the safest working environment possible for all site personnel. Design provisions and health and safety policies would comply with OSHA standards and consist of, but not be limited to, the following:

- Safe egress from all confined areas;
- Adequate ventilation of all enclosed work areas;
- Fire protection;
- Pressure relief of all pressurized equipment to a safe location;
- Isolation of all hazardous substances to a confined and restricted location;
- Separation of fuel storage from oxidizer storage;
- Prohibition of smoking in the workplace; and
- Real-time monitoring for hazardous chemicals with local and control room annunciation and alarm.

Industrial Safety Impacts

The operational workforce is expected to average about 200 employees. As shown in Table 6.17-3, the number of calculated fatalities for operation of this facility would be less than one.

Table 6.17-3. Calculated Annual Occupational Injury/Illness and Fatality Cases for Power Plant Operation

Number of Employees	Total Recordable Cases	Lost Work Day Cases	Fatalities
200	2	1	0.002

Risk of Fire or Explosion

Operation of the proposed facility would involve the use of flammable and combustible materials that could pose a risk of fire or explosion. The potential for fire or explosion at the proposed power plant would be minimized through design and engineering controls, including fire protection systems. The risks of fire and explosion could be minimized also through good housekeeping practices and the proper storage of chemicals. Workers would consult MSDS information to ensure that only compatible chemicals are stored together. Impacts of a potential large or catastrophic explosion are discussed in Section 6.17.3.2.

Risk of Hazardous Chemical Release or Spill

Chemicals and hazardous substances would be delivered, used, and stored at the proposed project site during operation. Petroleum products used on site during operation would be stored following the same guidelines described for construction. During operation, the worst-case scenario would be a major leak during chemical cleaning of equipment and associated piping.

The presence of hazardous environments during normal operations is not anticipated. Plant equipment would be installed, maintained, and tested in a manner that reduces the potential for inadvertent releases. Scheduled and forced maintenance would be planned to incorporate engineering and administrative controls to provide worker protection as well as mitigate any possible chemical releases. Facility and spot ventilation would provide for the timely removal and treatment of volatile chemicals. Worker practices and facility maintenance procedures would provide for the containment and cleanup of non-volatile chemicals. Personnel and area monitoring will provide assurance that worker exposures are maintained well below regulatory limits.

Seven chemical compounds are identified that could produce harmful effects in exposed individuals. The severity of these effects is dependent on the level of exposure, the duration of the exposure, and individual sensitivities to the various chemical compounds. Table 6.17-4 describes chemical exposure limits, potential exposure routes, organs targeted by the compounds, and the range of symptoms associated with exposures to these chemicals. The occupational exposure limits are defined in Table 6.17-5. Potential public exposures to accidental releases of these chemicals are described in Section 6.17.3.2.

While some of the chemicals listed in Table 6.17-4 would be generated during proposed power plant operation, others would be stored on site and the potential for personnel exposure as the result of minor spills or leaks, while low, exists.

Table 6.17-4. Properties and Hazards Associated with Chemicals of Concern

Chemical	Exposure Limits	Exposure Routes	Target Organs	Symptoms
Ammonia (NH_3)	**NIOSH REL**: TWA 25 ppm, ST 35 ppm **OSHA PEL**: TWA 50 ppm **IDLH**: 300 ppm	Inhalation, ingestion (solution), skin and eye contact (solution/liquid)	Eyes, skin, respiratory system	Irritation in eyes, nose, throat; dyspnea (breathing difficulty), wheezing, chest pain; pulmonary edema; pink frothy sputum; skin burns, vesiculation; liquid: frostbite
Carbon Dioxide (CO_2)	**NIOSH REL**: TWA 5,000 ppm ST 30,000 ppm **OSHA PEL**: TWA 5,000 ppm **IDLH**: 40,000 ppm	Inhalation, skin and eye contact (liquid/solid)	Respiratory and cardiovascular systems	Headache, dizziness, restlessness, paresthesia; dyspnea (breathing difficulty); sweating, malaise (vague feeling of discomfort); increased heart rate, cardiac output, blood pressure; coma; asphyxia; convulsions; liquid: frostbite
Carbon Monoxide (CO)	**NIOSH REL**: TWA 35 ppm; C 200 ppm **OSHA PEL**: TWA 50 ppm **IDLH**: 1200 ppm	Inhalation, skin and eye contact (liquid)	Cardiovascular system, lungs, blood, central nervous system	Headache, tachypnea, nausea, lassitude (weakness, exhaustion), dizziness, confusion, hallucinations; cyanosis; depressed S-T segment of electrocardiogram, angina, syncope
Chlorine (Cl_2)	**NIOSH REL**: C 0.5 ppm [15-minute] **OSHA PEL**: C 1 ppm **IDLH**: 10 ppm	Inhalation, skin and eye contact	Eyes, skin, respiratory system	Burning of eyes, nose, mouth; lacrimation (discharge of tears), rhinorrhea (discharge of thin mucus); cough, choking, substernal (occurring beneath the sternum) pain; nausea, vomiting; headache, dizziness; syncope; pulmonary edema; pneumonitis; hypoxemia (reduced oxygen in the blood); dermatitis; liquid: frostbite
Hydrogen Chloride (HCl)	**NIOSH REL**: C 5 ppm **OSHA PEL**: C 5 ppm **IDLH**: 50 ppm	Inhalation, ingestion (solution), skin and eye contact	Eyes, skin, respiratory system	Irritation in nose, throat, larynx; cough, choking; dermatitis; solution: eye, skin burns; liquid: frostbite; in animals: laryngeal spasm; pulmonary edema

Table 6.17-4. Properties and Hazards Associated with Chemicals of Concern

Chemical	Exposure Limits	Exposure Routes	Target Organs	Symptoms
Hydrogen Sulfide (H_2S)	**NIOSH REL**: C 10 ppm [10-minute] **OSHA PEL**: C 20 ppm 50 ppm [10-minute maximum peak] **IDLH** 100 ppm	Inhalation, skin and eye contact	Eyes, respiratory system, central nervous system	Irritation in eyes, respiratory system; apnea, coma, convulsions; conjunctivitis, eye pain, lacrimation (discharge of tears), photophobia (abnormal visual intolerance to light), corneal vesiculation; dizziness, headache, lassitude (weakness, exhaustion), irritability, insomnia; gastrointestinal disturbance; liquid: frostbite
Sulfur Dioxide (SO_2)	**NIOSH REL**: TWA 2 ppm ST 5 ppm **OSHA PEL**: TWA 5 ppm **IDLH**:100 ppm	Inhalation, skin and eye contact	Eyes, skin, respiratory system	Irritation in eyes, nose, throat; rhinorrhea (discharge of thin mucus); choking, cough; reflex bronchoconstriction; liquid: frostbite

Source: NIOSH, 2007.
NIOSH = National Institute of Occupational Safety and Health.
OSHA = Occupational Safety and Health Administration.
IDLH = Immediately Dangerous to Life and Health.
PEL = Permissible Exposure Limit.
REL = Recommended Exposure Limit.
TWA = Time-Weighted Average.
ST = Short-term.
C = Ceiling.

Table 6.17-5. Definitions of Occupational Health Criteria

Hazard Endpoint	Description
NIOSH REL C	NIOSH recommended exposure limit (REL). A ceiling value. Unless noted otherwise, the ceiling value should not be exceeded at any time.
NIOSH REL ST	NIOSH REL. Short-term exposure limit (STEL), a 15-minute TWA exposure that should not be exceeded at any time during a workday.
NIOSH REL TWA	NIOSH REL. TWA concentration for up to a 10-hour workday during a 40-hour work week.
OSHA PEL C	Permissible exposure limit (PEL). Ceiling concentration that must not be exceeded during any part of the workday; if instantaneous monitoring is not feasible, the ceiling must be assessed as a 15-minute TWA exposure.
OSHA PEL TWA	PEL. TWA concentration that must not be exceeded during any 8-hour work shift of a 40-hour workweek.
IDLH	Airborne concentration from which a worker could escape without injury or irreversible health effects from an IDLH exposure in the event of the failure of respiratory protection equipment. The IDLH was evaluated at a maximum concentration above which only a highly reliable breathing apparatus providing maximum worker protection should be permitted. In determining IDLH values, NIOSH evaluated the ability of a worker to escape without loss of life or irreversible health effects along with certain transient effects, such as severe eye or respiratory irritation, disorientation, and incoordination, which could prevent escape. As a safety margin, IDLH values are based on effects that might occur as a consequence of a 30-minute exposure.

NIOSH = National Institute of Occupational Safety and Health.
OSHA = Occupational Safety and Health Administration.
IDLH = Immediately Dangerous to Life and Health.
PEL = Permissible Exposure Limit.
REL = Recommended Exposure Limit.
TWA = Time-Weighted Average.
ST = Short-term.
C = Ceiling.

The FutureGen Project would use aqueous NH_3 in a selective catalytic reduction process to remove NO_X and thousands of pounds could be stored on-site. Three scenarios for the accidental release of NH_3 were evaluated using the EPA's ALOHA model: a leak from a tank valve, a tanker truck spill, and a tank rupture. (See Appendix F for summary of how the model was used, a description of input data, and the results of sensitivity analyses.) Health effects from inhalation of NH_3 can range from skin, eye, throat, and lung irritation; coughing; burns; lung damage; and even death. Impacts of NH_3 releases on workers and the public depends on the location of the releases, the meteorological conditions (including atmospheric stability and wind speed and direction) and other factors. The criteria used to examine potential health effects, are defined in Table 6.17-6 and Table 6.17-7.

Table 6.17-6. Hazard Endpoints for Individuals Potentially Exposed to an Ammonia Spill

Exposure Time	Gas	Effect Category	Concentration (ppmv)	Hazard Endpoint[1]
1 hour	NH_3	Adverse effects	30	AEGL 1
		Irreversible adverse effects	160	AEGL 2
		Life Threatening	1,100	AEGL 3

[1]See Table 6.17-7 for descriptions of the AEGL endpoints.
AEGL = Acute Exposure Guideline Level.

Table 6.17-7. Description of Hazard Endpoints for Ammonia Spill Receptors

Hazard Endpoint	Description
AEGL 1	The airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic, non-sensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure.
AEGL 2	The airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting adverse health effects, or an impaired ability to escape.
AEGL 3	The airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening health effects or death.

AEGL = Acute Exposure Guideline Level.
Source: EPA, 2007.

Leakage of 400 pounds (180 kilograms) of aqueous NH_3 solution (19 percent NH_3) from a tank, through a faulty valve, was selected as a plausible upper-bound accidental spill. It was assumed that this release would create a one-centimeter deep pool, with a surface area of 211 square feet (19.6 square meters). The temperature of the solution was assumed to be 104°F (40°C), based on the maximum daily air temperature in Jewett for the past three years. Downwind atmospheric concentrations of volatilized (vapor-phase) NH_3 were calculated using a wind speed of 1.5 m/sec, Pasquill atmospheric stability class F (most conservative) using EPA's ALOHA model, which assumes a source duration of up to one hour. Concentrations within 2,858 feet (871 meters) of the pool would exceed AEGL Level 1 criteria for temporary health effects (30 ppmv – 1 hour) (see Table 6.17-8). Individuals exposed within a distance of 1,295 feet (395 meters) of the pool would be expected to experience NH_3 concentrations above AEGL Level 2 for irreversible adverse effects (160 ppmv – 1 hour), while life threatening exposures (AEGL Level 3, i.e., 1,100 ppmv – 1 hour) could occur only within 548 feet (167 meters) of the spill. Thus, only workers (assumed to be within 250 meters of a release) could potentially be exposed to life-threatening levels of atmospherically dispersed NH_3.. The peak concentrations are predicted to last about 10 minutes, and would not exceed the AEGL-3 criteria of 2,700 ppmv for a 10-minute exposure at 250 meters.

For the tanker truck spill scenario, it was assumed that all 46,200 pounds (20,956 kilograms) of the 19 percent NH_3 solution in the truck may be spilled on the ground surface. It was assumed that this release would create a ten-centimeter deep pool, with a surface area of 2,454 square feet (228 square meters). The temperature of the solution was assumed to be 104°F (40°C), based on the maximum daily air temperature in Jewett for the past three years. Downwind atmospheric concentrations of volatilized (vapor-phase) NH_3 were calculated using a wind speed of 1.5 m/sec, Pasquill atmospheric stability class F (most conservative) using EPA's ALOHA model, which assumes a source duration of up to one hour. Concentrations within 15,092 feet (4,600 meters) of the pool would exceed AEGL Level 1 criteria for temporary health effects (30 ppmv – 1 hour) (see Table 6.17-8). Individuals within a distance of 5,577 feet (1,700 meters) of the pool would be expected to experience NH_3 concentrations above AEGL Level 2 for irreversible adverse effects (160 ppmv – 1 hour), while life threatening exposures (AEGL Level 3, i.e., 1,100 ppmv – 1 hour) could occur within 1,969 feet (600 meters) of the spill. Thus, workers and the general public (assumed to be located at least 820 feet [250 meters] from a release) could potentially be exposed to life-threatening levels of atmospherically dispersed NH_3. The peak concentrations are predicted to last about 10 minutes, and would exceed the AEGL-3 criteria of 2,700 ppmv for a 10-minute exposure at 820 feet (250 meters), but not inside a building.

For the tank rupture spill scenario, it was assumed that all 104,355 pounds (13,400 kilograms) of the 19 percent NH_3 solution in one of two on-site storage tanks may be released within the diked area around the tank. The tank discharge was assumed to create a 92-centimeter deep pool with a surface area of 601 square feet (55.8 square meters). Again the temperature of the solution was conservatively assumed to be 104°F (40°C). The same atmospheric conditions as above, and EPA's ALOHA model with a source duration of 1 hour were used to calculate downwind atmospheric NH_3 concentrations. Concentrations within 8,530 feet (2,600 meters) of the pool would exceed AEGL Level 1 criteria for temporary health effects (30 ppmv – 1 hour) (see Table 6.17-8). Individuals within a distance of 3,140 feet (957 meters) of the pool would be expected to experience NH_3 concentrations above AEGL Level 2 for irreversible adverse effects (160 ppmv – 1 hour), while life threatening exposures (AEGL Level 3, i.e., 1,100 ppmv – 1 hour) could occur within 1,079 feet (329 meters) of the spill. Thus, workers and the general public (assumed to be located 820 feet [250 meters] at least from a release) could potentially be exposed to life-threatening levels of atmospherically dispersed NH_3. The peak concentrations are predicted to last about 10 minutes, and would not exceed the AEGL-3 criteria of 2,700 ppmv for a 10-minute exposure at 820 feet (250 meters).

The meteorological conditions specified for these analyses (F stability class) result in conservative estimates of exposure. At Jewett, this stability class occurs about 21 percent of the time. Simulations of the other six stability classes showed that the predicted distances to a given criteria were no more than 35 percent of the distance for the conservative stability class F. The stability class (D8), which gave the second highest results, occurs about 8.4 percent of the time. Since NH_3 produces a distinct, pungent odor at low concentrations (approximately 17 ppmv (AIHA, 1997), it is expected that most workers and the public in the vicinity of an accident would quickly evacuate under the scenarios discussed above. Depending on the size and location of the accident, the public would be alerted to the appropriate response such as shelter-in-place procedures or evacuation for the public living near the accident.

Sections 6.17.3.2 and 6.17.4 discuss scenarios involving equipment failure or rupture at the proposed power plant site, along utility corridors, and at the injection site.

Medical Emergencies

All permanent employees at the facility would receive first aid and CPR training. On-site treatment would be provided in medical situations that require only first aid treatment or stabilization of the victim(s) until professional medical attention is obtained. Any injury or illness that requires treatment beyond first aid would be referred to the plant's medical clinic or to a local medical facility.

Coal Storage

The National Fire Protection Association (NFPA) identifies hazards associated with storage and handling of coal, and gives recommendations for protection against these hazards. NFPA recommends that any storage structures be made of non-combustible materials, and that they be designed to minimize the surface area on which dust can settle, including the desirable installation of cladding underneath a building's structural elements.

Table 6.17-8. Effects of an Ammonia Spill at the Proposed Power Plant

Release Scenario	Gas	Effect[1]	Distance (feet [meters])
NH_3 leaky valve (400 pounds, 19 percent solution)	NH_3	Adverse Effects	2,857 (871)
		Irreversible adverse effects	1,296 (395)
		Life threatening effects	548 (167)
NH_3 tanker truck spill (46,200 pounds, 19 percent solution)	NH_3	Adverse Effects	15,092 (4,600)
		Irreversible adverse effects	5,577 (1,700)
		Life threatening effects	1,969 (600)
NH_3 tank rupture (104,355 pounds, 19 percent solution)	NH_3	Adverse Effects	8,530 (2,600)
		Irreversible adverse effects	3,140 (957)
		Life threatening effects	1,079 (329)

[1] See Table 6.17-6 and Table 6.17-7 for an explanation of the effects.

Coal is susceptible to spontaneous combustion due to heating during natural oxidation of new coal surfaces. Also, coal dust is highly combustible and an explosion hazard. If a coal dust cloud is generated inside an enclosed space and an ignition source is present, an explosion can ensue. Dust clouds may be generated wherever loose coal dust accumulates, such as on structural ledges; or if there is a nearby impact or vibration due to wind, earthquake, or even maintenance operations. Because of coal's propensity to heat spontaneously, ignition sources are almost impossible to eliminate in coal storage and handling, and any enclosed area where loose dust accumulates is at great risk. Further, even a small conflagration can result in a catastrophic "secondary" explosion if the small event releases a much larger dust cloud.

A Quonset hut-type building for on-site coal storage is being examined (FG Alliance, 2006e). This structure would protect the pile from rain and wind, which would otherwise foster spontaneous combustion in open-air piles and cause air and runoff pollution. Internal cladding would prevent dust accumulation on the structure. A breakaway panel may provide for accidental overloading and ventilation at the base, and exhaust fans or ventilation openings ensure against methane or smoke buildup. Dust suppression/control techniques would be employed. Fire detection and prevention systems may also be installed.

The surfaces of stored coal can be unstable, and workers can become entrapped and subsequently suffocate while working on stored coal piles (NIOSH, 1987). NIOSH recommendations for preventing entrapment and suffocation would be followed.

Sequestration Site

Industrial Safety Impacts

The operational workforce for the proposed sequestration site would be up to 20 employees. Since this proposed site would not be a permanently staffed facility, these personnel would be rotated from the permanent site pool. Based on these employment numbers, during operation of the proposed power plant, the TRCs, LWDs, and fatalities presented in Table 6.17-9 would be expected. As shown in Table 6.17-9, the number of calculated fatalities for operation of this facility would be less than one.

Table 6.17-9. Calculated Annual Occupational Injury and Fatality Cases for Sequestration Site Operation

Number of Employees	Total Recordable Cases	Lost Work Day Cases	Fatalities
20	<1	<1	0.0002

Utility Corridors

Risk of Fire or Explosion

The proposed transmission line connector would be located high above ground (typically between 50 to 100 feet [15.2 to 30.5 meters] high). Only qualified personnel would perform maintenance on the proposed transmission lines. Sufficient clearance would be provided for all types of vehicles traveling under the proposed transmission lines. The operator of the line would establish and maintain safe clearance between the tops of trees and the proposed transmission lines to prevent fires. Ground and counterpoise wires would be installed on the proposed transmission system, providing lightning strike protection and thereby reducing the risk of explosion. However, a brush fire could occur in the rare event that a conductor parted and one end of the energized wire fell to the ground, or perhaps in the event of lightning strikes. Under these rare circumstances, the local fire department would be called upon.

Releases or Potential Releases of Hazardous Materials to the Environment

Hazardous materials used during maintenance of the proposed transmission facilities would be limited to gasoline, diesel fuel, motor oil, hydraulic fluid, solvents, cleaners, sealants, welding flux and gases, various lubricants, paint, and paint thinner. Small quantities of fuel, oil, and grease may leak from maintenance equipment. Such leakage should not be a risk to health and safety or the environment because of low relative toxicity and low concentrations.

Industrial Safety Impacts

The operational workforce for the proposed utility corridors would be less than 20 employees. As with the proposed sequestration site, the majority of these workers would not be on permanent assignment and would be drawn from the plant pool. Based on these employment numbers, during operation and maintenance of utility corridors, the TRCs, LWDs, and fatalities presented in Table 6.17-10 would be expected. As shown in Table 6.17-10, the number of calculated fatalities for operation of this facility would be less than one.

Table 6.17-10. Calculated Annual Occupational Injury and Fatality Cases for Utility Corridors Operation

Number of Employees	Total Recordable Cases	Lost Work Day Cases	Fatalities
20	<1	<1	0.0002

Transportation Corridors

Facility personnel would not be involved in activities associated with these infrastructure operations. Rail and road transportation activities would be performed by non-facility employees and vendors. Hazards related to the proposed transportation corridor operation would not be different from those posed by the normal transportation risks associated with product delivery.

6.17.3 AIR EMISSIONS

6.17.3.1 Air Quality – Normal Operations

Air quality impacts on human health were evaluated for HAPs potentially released during normal operation of the proposed Jewett Power Plant and proposed sequestration site. HAP emissions from the FutureGen Project were estimated based on the Orlando Gasification Project. The methods used to analyze impacts are described in Section 6.2.3 with supporting materials in Appendix E. Assessment of the potential toxic air pollutant emissions demonstrated that all ambient air quality impacts for air toxics would be below the relevant EPA recommended exposure criteria. This section of the report provides a summary of the results of potential air quality impacts.

As described in Section 6.2.3 regarding the modeling approach, estimated emissions of HAPs were based on data taken from the Orlando Gasification Project (DOE, 2007). Although the Orlando project is an IGCC power plant, there are differences from the proposed project. Consequently, the Orlando project data were scaled, based on relative emission rates of VOCs and particulate matter, to produce more appropriate estimates of stack emissions from the proposed project.

Airborne HAP concentrations were determined by modeling the impact of 1 g/s emission rate using AERMOD. Table 6.17-11 shows representative air quality impacts for several metallic and organic toxic air pollutants. Each of these airborne concentrations was evaluated using chronic exposure criteria (expressed as inhalation unit risk factors and reference concentrations) obtained from the EPA Integrated Risk Information System (IRIS) (EPA, 2006a). As appropriate, an inhalation unit risk factor was multiplied by the maximum annual average airborne concentration for each HAP to calculate a cancer risk. Hazard coefficients were calculated by dividing the maximum annual average airborne concentration for each HAP by the appropriate reference concentration taken from the EPA IRIS (EPA, 2006a). The cancer risks and hazard coefficients calculated for each HAP were then summed and compared to the EPA criteria for evaluating HAP exposures. The results of this analysis, as indicated in Table 6.17-11, show that predicted exposures are safely well below the EPA exposure criteria.

Normal Air Quality and Asthma

Asthma is a chronic respiratory disease characterized by attacks of difficulty breathing. It is a common chronic disease of childhood, affecting over 6.5 million children in the U.S. in 2005 and contributing to over 12.8 million missed school days annually (DHHS, 2006). In 2005, the prevalence of asthma among children in the U.S. was 8.9 percent. Asthma prevalence rates among children remain at historically high levels after a large increase from 1980 until the late 1990s.

Asthma-related hospitalizations followed a trend similar to those for asthma prevalence, rising from 1980 through the mid-1990s, remaining at historically high plateau levels. Asthma-related mortality rates in the U.S. have declined recently after a rising trend from 1980 through the mid-1990s (DHHS, 2006).

It remains unknown why some people get asthma and others do not (DHHS, 2006). Asthma symptoms are triggered by a variety of things such as allergens (e.g., pollen, dust mites, and animal dander), infections, exercise, changes in the weather, and exposure to airway irritants (e.g., tobacco smoke and outdoor pollutants). Although extensive evidence shows that ambient air pollution (based on measurements of NO_2, particulate matter, soot, and O_3) exacerbates existing asthma, a link with the development of asthma is less well established (Gilmour et al., 2006).

Table 6.17-11. Summary Analysis Results — Hazardous Air Pollutants

Chemical Compound	CT/HRSG Emissions[1]		Inhalation Unit Risk Factor[2] (μg/m^3)$^{-1}$	Reference Concentration[2] (μg/m^3)$^{-1}$	Cancer Risk[3]	Hazard Coefficient[4]
	(lb/hr)	(g/s)				
2-Methylnaphthalene	1.99E-04	2.51E-05	n/a	n/a	n/a	n/a
Acenaphthyalene	1.44E-05	1.81E-06	n/a	n/a	n/a	n/a
Acetaldehyde	9.99E-04	1.26E-04	2.20E-06	9.00E+00	7.28E-12	3.68E-07
Antimony	**5.59E-03**	**7.04E-04**	n/a	**2.00E-01**	n/a	**9.27E-05**
Arsenic	**2.94E-03**	**3.70E-04**	**4.30E-03**	**3.00E-02**	**4.19E-08**	**3.25E-04**
Benzaldehyde	1.61E-03	2.03E-04	n/a	n/a	n/a	n/a
Benzene	2.69E-03	3.39E-04	7.80E-06	3.00E+01	6.97E-11	2.98E-07
Benzo(a)anthracene	1.28E-06	1.61E-07	1.10E-04	n/a	4.65E-13	n/a
Benzo(e)pyrene	3.05E-06	3.84E-07	8.86E-04	n/a	8.94E-12	n/a
Benzo(g,h,i)perylene	5.26E-06	6.63E-07	n/a	n/a	n/a	n/a
Beryllium	**1.26E-04**	**1.59E-05**	**2.40E-03**	**2.00E-02**	**1.00E-09**	**2.09E-05**
Cadmium	**4.06E-03**	**5.12E-04**	**1.80E-03**	**2.00E-02**	**2.42E-08**	**6.73E-04**
Carbon Disulfide	2.49E-02	3.14E-03	n/a	7.00E+02	n/a	1.18E-07
Chromium[5]	**3.78E-03**	**4.76E-04**	**1.20E-02**	**1.00E-01**	**1.50E-07**	**1.25E-04**
Cobalt	**7.97E-04**	**1.00E-04**	n/a	**1.00E-01**	n/a	n/a
Formaldehyde	1.85E-02	2.33E-03	5.50E-09	9.80E+00	3.36E-13	n/a
Lead	**4.06E-03**	**5.12E-04**	n/a	**1.50E+00**	n/a	**8.98E-06**
Manganese	**4.34E-03**	**5.47E-04**	n/a	**5.00E-02**	n/a	**2.88E-04**
Mercury	**1.27E-03**	**1.60E-04**	n/a	**3.00E-01**	n/a	**1.41E-05**
Naphthalene	2.95E-04	3.72E-05	3.40E-05	3.00E+00	n/a	3.26E-07
Nickel	**5.45E-03**	**6.87E-04**	**2.40E-04**	**9.00E-02**	**4.34E-09**	**2.01E-04**
Selenium	**4.06E-03**	**5.12E-04**	n/a	**2.00E+01**	n/a	**6.73E-07**
Toluene	4.12E-04	5.19E-05	n/a	4.00E+02	n/a	3.41E-09
TOTAL					2.22E-07	1.75E-03
Risk Indicators					1.00E-06	1.00E+00
Percent of Indicator					22.2 percent	0.17 percent

[1] Emission rates scaled by the ratio of VOC or particulate emissions from Orlando EIS to FutureGen.
[2] Provided by EPA Integrated Risk Information System (IRIS).
[3] Unit risk factor multiplied by maximum annual average impact of 0.0263 μg/m^3 determined by AERMOD at a 1 g/s emission rate.
[4] Maximum AERMOD annual average impact divided by reference concentration.
Notes:
CT/HRSG = combustion turbine/heat recovery steam generator; lb/hr = pounds per hour; g/s = grams per second; μg/m^3 = micrograms per cubic meter; n/a = not available.
[5] Conservatively assumed all chromium to be hexavalent.
Compounds that are considered to be particulate matter in **bold** text.

A 2006 workshop sponsored by the EPA and the National Institute of Environmental Health Sciences (Selgrade et al., 2006) found that there are a number of scientific questions that need to be answered in order to make appropriate regulatory decisions for ambient air, including which air pollutants are of greatest concern and at what concentrations. Nevertheless, IGCC power plants that are currently in operation have achieved the lowest levels of criteria air pollutant (SO_2, CO, O_3, NO_2, Pb, and respirable particulate matter) emissions of any coal-fueled power plant technologies (DOE, 2002). Tables 6.2-1 and 6.2-2 also show that the IGCC technology under evaluation for the proposed project would exceed the performance of technologies used at more conventional types of coal-fueled power plants of comparable size. Furthermore, based on evaluations conducted for this site (as described in Section 6.2), the maximum predicted concentrations of the criteria air pollutants would not exceed the National Ambient Air Quality Standards and would not significantly contribute to existing background levels. Based on these determinations, it is unlikely that the proposed project would be a factor in asthma-related health effects.

6.17.3.2 Hazard Analysis

The Consequence-Based Risk Ranking Study for the Proposed FutureGen Project Configurations (referred to hereafter as the Quest Study) was conducted to define creditable upperbound impacts from potential accidental releases of toxic and flammable gas from the proposed systems (Quest, 2006). Risks associated with gas releases include asphyxiation, exposure to toxic gas clouds, flash fires, torch fires, and vapor cloud explosions.

A particular concern associated with the release of gas is exposure to a toxic component within the dispersing gas cloud. Many of the process streams of the proposed power plant could contain one or more toxic components. The Quest Study evaluated the extent of exposure to gas clouds containing NH_3, CO, Cl_2, HCl, H_2S, and SO_2. Additional analyses were performed to define the extent of potential asphyxiation hazard associated with exposure to high concentrations of CO_2.

The hazard of interest for flash fires was direct exposure to flames. Flash fire hazard zones were determined by calculating the maximum size of the flammable gas cloud before ignition. The LFL of the released hydrocarbon mixture was used as a boundary. The hazard of interest for the torch fires (ignition of a high velocity release of a flammable fluid, such as a hydrogen deflagration) was exposure to thermal radiation from the flame (Quest, 2006). For vapor clouds explosions, the hazard of interest was the overpressure created by the blast wave. For toxic components, potential impacts were determined by calculating the maximum distance at which health effects could occur.

Plant System Configurations

For the purposes of the analysis, the facility was assumed to be located in an area of reasonably flat terrain with limited vertical obstructions. This provided the bounding conditions that allow for the most conservative hazard impact analysis (Quest, 2006).

For the base case evaluation, the main process components for each of the proposed power plant configurations were laid out in a rectangular area approximately 75 acres (30 hectares) in size. This area was surrounded by the rail line used to deliver the coal. The total area required for the proposed project would consist of a minimum of 200 acres (81 hectares) (Quest, 2006).

Three other cases were also evaluated. Assuming the proposed facility is placed in the middle of a 200-, 400-, or 600-acre (81-, 162-, or 243-hectare) site, it was determined whether any explosion would extend beyond the boundaries of each site configuration.

Summary of Results

A full evaluation of the hazards associated with the preliminary designs of the four proposed gasifier systems for use in the proposed project was performed. This analysis was composed of the following three primary tasks:

- Task 1: Determine the maximum credible potential releases, for each process unit within each proposed system configuration for each candidate coal source.
- Task 2: For each release point identified in Task 1, determine the maximum downwind travel for harmful, but not fatal, consequences of the release under worst-case atmospheric conditions.

- Task 3: Using the results of Task 2 and the available general layout information for the proposed system configurations, develop a methodology to rank the potential impacts to the workers on site and the potential off-site public population.

Hazards Identification

In general, all four of the gasifier systems evaluated for the FutureGen Project are composed of similar equipment. All gas processing equipment downstream of the gasifier is in common use in the petroleum industry and does not provide any unique hazards (Quest, 2006).

Upperbound-Case Consequence Analysis

The Quest Study evaluated the largest releases to determine the extent of possible flammable and toxic impacts under maximum (upperbound) release conditions. The analysis included a combination of four gasifiers and three types of coal (12 gasifier/coal combinations). The impacts were defined as those that could cause injury to workers or members of the public.

None of the flammable hazards were found to have impacts that extended beyond the proposed plant property. The largest flash fire impact zones extended less than 200 feet (61.0 meters) from the point of release. Areas within the process units in each of the four project system designs would have the potential to be impacted by flammable releases. This result is not unexpected for a facility handling similar materials (Quest, 2006).

The upperbound for toxic impacts associated with the 12 gasifier/candidate coal combinations evaluated would have the potential to extend past the proposed project property line. The toxic impacts would be dominated by releases of H_2S and SO_2 from the Claus process unit. The resulting plumes could extend from 0.3 to 1.4 miles (0.5 to 2.3 kilometers) from the point of release. There are no family residences or farm home sites within the 1.4-mile (2.3-kilometer) plume release radius. However, portions of the Limestone generating station and the Jewett Mine properties are within this footprint. The total number of workers potentially affected by these releases is not certain, although 373 workers are reportedly employed at the Jewett Mine (Texas Westmoreland Coal Co., 2005).

The longest downwind toxic impact distance associated with any of the four gasifiers is due to the CO in the syngas process stream. These streams can produce toxic CO impacts extending from 0.4 to 0.6 mile (0.6 to 1.0 kilometer) from the point of release (Quest, 2006). There are no family residences, farm home sites or commercial properties within the 0.6-mile (1.0-kilometer) release footprint radius.

The potential health risks to these receptors are discussed in more detail in Section 6.17.5.

Hazard Ranking

Using the results from Tasks 1 and 2, a framework for ranking the flammable and toxic impacts associated with the upperbound release was designed as a function of the location of a worker or member of the public relative to the facility process units. Four zones were developed; two for the workers inside the property line and two for the public outside of the property lines (Quest, 2006).

Since none of the flammable hazards were found to have impacts that extended past the property line, there would be no off-site or public impacts due to flammable releases within the facility process units (Quest, 2006).

The upperbound for toxic impacts associated with all 12 gasifier/coal candidate combinations would have the potential to extend past the proposed project property line. In 11 of the 12 gasifier/candidate coal combinations, toxic impacts associated with the Claus unit would be greater than the impacts from any other process unit (Quest, 2006).

In general, all 12 gasifier/candidate coal systems would have the potential to produce toxic impacts that could extend into a public area outside of the property line for the 200-acre (81-hectare) base case layout. By this measure, all four gasifier systems, regardless of candidate coal, have the potential to produce similar worst-case impacts and thus, are ranked equally. This conclusion is also true for a 400-acre (162-hectare) layout and is true for 11 of the 12 gasifier/candidate coal systems assuming a 600-acre (243-hectare) site (Quest, 2006).

Conclusions

The identification and evaluation of the largest potential releases associated with the four gasifier system designs for the proposed project results in the following findings:

- There are no flammable hazard impacts that extend off the proposed project property.
- All four gasifier designs produce similar toxic hazards. No design demonstrates a clear advantage over others in this respect.
- The potential toxic impacts associated with the four gasifier system designs are dominated by releases of H_2S and SO_2 from the Claus unit that is included in each design.
- All three candidate coals, when used as feed to any of the four gasifier designs, have the potential to produce off-site toxic impacts. The Powder River Basin coal, used in any of the gasifiers, produces slightly smaller toxic impact distances strictly due to its lower sulfur content, and thus, lower H_2S flow rates to the Claus unit (Quest, 2006).

6.17.4 RISK ASSESSMENT FOR CO_2 SEQUESTRATION

The "Final Risk Assessment Report for the FutureGen Project Environmental Impact Statement" (Tetra Tech, 2007) describes the results of the human health risk assessment conducted to support the proposed project. The risk assessment addresses the potential releases of captured gases at the proposed power plant, during transport via pipeline to the proposed geologic storage site, and during subsurface storage.

The approach to risk analysis for CO_2 sequestration in geologic formations is still evolving. However, a substantial amount of information exists on the risks associated with deep injection of hazardous waste and the injection of either gaseous or supercritical CO_2 in hydrocarbon reservoirs for enhanced oil recovery. There are also numerous projects underway at active CO_2 injection sites that are good analogs to determine the long-term fate of CO_2. The FutureGen Project assessment relies heavily on the findings from these previous and ongoing projects.

6.17.4.1 CO_2 Sequestration Risk Assessment Process

The human health risk assessment is presented in five sections: conceptual site models (CSMs); toxicity data and benchmark concentration effect levels; pre-injection risk assessment; the post-injection risk assessment; and the risk screening and performance assessment. The results of the risk screening of CO_2 sequestration activities are presented in 6.17.4.2.

Conceptual Site Models

A central task in the risk assessment was the development of the CSMs. Potential pathways of gas release during capture, transport, and storage were identified for the pre- and post-injection periods. Site-specific elements of the Jewett Site were described in detail based on information from the EIVs provided by the FutureGen Alliance (FG Alliance, 2006a - d). These data provided the basis for the CSM parameters and the analysis of likely human health exposure routes.

Toxicity Data and Benchmark Concentration Effect Levels

The health effect levels were summarized for the identified exposure pathways. The toxicity assessment provides information on the likelihood of the chemicals of potential concern to cause adverse human-health effects. These data provided the basis for the comparison of estimated exposures and the assessment of potential risks.

Risk Screening and Performance Assessment

Pre-Injection Risk Assessment

This assessment evaluated the potential risks associated with the proposed plant and aboveground facilities for separating, compressing, and transporting CO_2 to the proposed injection site. The risk assessment for the pre-injection components was based on qualitative estimates of fugitive releases of captured gases and quantitative estimates of gas releases from aboveground sources under different failure scenarios. Failure scenarios of the system included: pipeline rupture, pipeline leakage through a puncture (3-square-inch [19.4-square-centimeter] hole), and rupture of the wellhead injection equipment. The volumes of gas released for the pipeline scenarios were calculated using site-specific data for the four sites and the equations for gas emission rates from pipelines (Hanna and Drivas, 1987).

In general, the amount of gas released from a pipeline rupture or puncture was the amount contained between safety valves, assumed to be spaced at 5-mile (8.0-kilometer) intervals. The amount of gas released by a wellhead rupture was assumed to be the amount of gas contained within the well casing itself. The atmospheric transport of the released gas was simulated using the SLAB model (Ermak, 1990), with the gas initially in a supercritical[1] state (pressure ~2000 psi, temperature ~90°F [32.2°C]). The evaluation was conducted for the case with CO_2 at 95 percent and H_2S at 100 ppmv. The predicted concentrations in air were used to estimate the potential for exposure and any resulting impacts on workers, off-site residents, and sensitive receptors.

Post-Injection Risk Assessment

The post-injection risk assessment describes the analysis of potential impacts from the release of CO_2 and H_2S after the injection into the subsurface CO_2 storage formation. A key aspect of the analysis was the compilation of an analog database that included the proposed site characteristics and results from studies performed at other CO_2 storage locations and from sites with natural CO_2 accumulations and releases. The analog database was used for characterizing the nature of potential risks associated with surface leakage due to caprock seal failures, faults, fractures, or wells. CO_2 leakage from the proposed project storage formation was estimated using a combination of relevant industry experience, natural analog studies, modeling, and expert judgment.

Qualitative risk screening of the proposed site was based upon a systems analysis of the site features and scenarios portrayed in the CSM. Risks were qualitatively weighted and prioritized using procedures identified in a health, safety, and environmental risk screening and ranking framework developed by Lawrence Berkeley National Laboratory for geologic CO_2 storage site selection (Oldenburg, 2005). In addition, further evaluation was conducted by estimating potential gas emission rates and durations using the analog database for a series of release scenarios. Three scenarios could potentially cause acute effects: upward leakage through the CO_2 injection wells; upward leakage through the deep oil and gas wells; and upward leakage through undocumented, abandoned, or poorly constructed wells.

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[1] A supercritical fluid occurs at temperatures and pressures where the liquid and gas phases are no longer distinct. The supercritical fluid has properties of both the gaseous and liquid states; normally its viscosity is considerably less than the liquid state, and its density is considerably greater than the gaseous state.

Six scenarios could potentially cause chronic effects: upward leakage through caprock and seals by gradual failure; release through existing faults due to effects of increased pressure; release through induced faults due to effects of increased pressure (local over-pressure)' upward leakage through the CO_2 injection wells; upward leakage through the deep oil and gas wells; and upward leakage through undocumented, abandoned, or poorly constructed wells. For the chronic-effects case for the latter three well scenarios, the gas emission rates were estimated to be at a lower rate for a longer duration. The predicted concentrations in air were then used to estimate the potential for exposure and any resulting impacts on workers, off-site residents, and sensitive receptors. Other scenarios including catastrophic failure of the caprock and seals above the sequestration reservoir and fugitive emissions are discussed, but were not evaluated in a quantitative manner.

6.17.4.2 Consequence Analysis

Risk Screening Results for Pre-Sequestration Conditions (CO_2 Pipeline and Injection Wellheads)

As with all industrial operations, accidents can occur as part of the CO_2 transport and sequestration activities. Of particular concern is the release of CO_2 and H_2S. The CO_2 sequestration risk assessment (Tetra Tech, 2006) identified three types of accidents that could potentially release gases into the atmosphere before sequestration. Accidents included ruptures and punctures of the pipeline used to transport CO_2 to the injection sites and rupture of the wellhead equipment at these sites. The frequency of these types of accidents along the pipelines or at the wellheads is expected to be low. The amount of gas released depends on the severity and the location of the accident (i.e., pipeline or wellhead releases).

Health effects from inhalation of high concentrations of CO_2 gas can range from headache, dizziness, sweating, and vague feelings of discomfort, to breathing difficulties, increased heart rate, convulsions, coma, and possibly death. Exposure to H_2S can cause health effects similar to those for CO_2, but at much lower concentrations. In addition H_2S can cause eye irritation, abnormal tolerance to light, weakness or exhaustion, poor attention span, poor memory, and poor motor function.

Accident Categories and Frequency Ranges

Likely: Accidents estimated to occur one or more times in 100 years of facility operations (frequency $\geq 1 \times 10^{-2}$/yr).

Unlikely: Accidents estimated to occur between once in 100 years and once in 10,000 years of facility operations (frequency from 1×10^{-2}/yr to 1×10^{-4}/yr).

Extremely Unlikely: Accidents estimated to occur between once in 10,000 years and once in 1 million years of facility operations (frequency from 1×10^{-4}/yr to 1×10^{-6}/yr).

Incredible: Accidents estimated to occur less than one time in 1 million years of facility operations (frequency < 1×10^{-6}/yr).

Impacts of CO_2 and H_2S gas releases on workers and the public depends on the location of the releases, the equipment involved, the meteorological conditions (including atmospheric stability and wind speed and direction), the directionality of any release from a puncture (e.g., upwards and to the side), and other factors. The effects to workers near a ruptured or punctured pipeline or wellhead are likely to be dominated by the physical forces from the accident itself, including the release of gases at high flow rates (3,000 kilograms per second) and at very high speeds (e.g., ~ 500 mph [804.7 kmph]). Thus, workers involved at the location of an accidental release would be impacted, possibly due to a combination of effects, such as physical trauma, asphyxiation (displacement of O_2), toxic effects, or frostbite from the rapid expansion of CO_2 (2,200 psi to 15 psi). Workers near a release up to a distance of 640 feet (195 meters) could also be exposed to very high concentrations of CO_2 (e.g., 170,000 ppm) for short durations of one minute, which would be life-threatening.

For this evaluation, risks to workers were evaluated at two distances: involved workers at a distance of 66 feet (20.1 meters) of a release and other workers at a distance of 820 feet (249.9 meters). For all ruptures or punctures these individuals may experience adverse effects up to and including irreversible effects when concentrations predicted using the SLAB model (Ermak, 1990) exceed health criteria. The criteria used for this determination were the RELs established as occupational criteria for exposures to CO_2 and H_2S, consisting, respectively, of a ST exposure limit (averaged over 15 minutes) for CO_2 and a ceiling concentration for H_2S that should not be exceeded at any time during a workday (NIOSH, 2007). Each of these criteria is listed in Table 6.17-4. Table 6.17-12 summarizes locations where pipeline and wellhead accidents create gas concentrations exceeding allowable levels for facility workers. Workers would be expected to be affected by CO_2 concentrations equal to or greater than 30,000 ppm from a pipeline rupture out to a distance of 663 feet (202 meters) or to a distance of 449 feet (137 meters) from a pipeline puncture. H_2S concentrations would exceed worker criteria at least out to a distance of the proposed plant boundary 820 feet (249.9 meters) for both the pipeline rupture and puncture.

Table 6.17-12. Exceedance of Occupational Health Criteria[1] for Workers

Release Scenario	Frequency Category[2]	Exposure Time	Gas	Area of Exceedance
Pipeline Rupture	U	Minutes	CO_2	Near pipeline only[3]
			H_2S	Within plant boundaries[4]
Pipeline Puncture[5]	L to U	Approximately 4 hours	CO_2	Near pipeline only[3]
			H_2S	Near pipeline only[3]
Wellhead Rupture	EU	Minutes	CO_2	None
			H_2S	Near wellhead only[3]

[1] Occupational health criteria used were the NIOSH reference exposure levels (REL), short-term (ST), and NIOSH REL ceiling (C) for CO_2 and H_2S, respectively. See Table 6.17-4.
[2] U(unlikely)=frequency of 1x 10^{-2}/yr to 1x 10^{-4}/yr; L (likely) = frequency of ≥ 1x 10^{-2}/yr ;EU (extremely unlikely)=frequency of 1x10^{-4}/yr to 1x 10^{-6}/yr.
[3] Distances are 663 feet (202 meters) for pipeline rupture; 449 feet (137 meters) for pipeline puncture; at least 161 feet (49 meters) for wellhead rupture.
[4] Within 820 feet (250 meters) of release.
[5] 3-inch by 1-inch rectangular opening in pipe wall.

A 2006 workshop sponsored by the EPA and the National Institute of Environmental Health Sciences (Selgrade et al., 2006) found that a number of scientific questions that need to be answered in order to make appropriate regulatory decisions for ambient air, including which air pollutants are of greatest concern and at what concentrations. Nevertheless, IGCC power plants that are currently in operation have achieved the lowest levels of criteria air pollutant (SO_2, CO, O_3, NO_2, Pb, and respirable particulate matter) emissions of any coal-fueled power plant technologies (DOE, 2002). Tables 6.2-1 and 6.2-2 also show that the IGCC technology under evaluation for the proposed project would exceed the performance of technologies used at more conventional types of coal-fueled power plants of comparable size. Furthermore, based on evaluations conducted for this site (as described in Section 6.2), the maximum predicted concentrations of the criteria air pollutants would not exceed the National Ambient Air Quality Standards and would not significantly contribute to existing background levels. Based on these determinations, it is unlikely that the proposed project would be a factor in asthma-related health effects.

There is also interest in whether ruptures or punctures may affect non-involved workers. Non-involved workers are those workers present within the proposed plant boundary distance, but employed in activities distant from the release point. The effects for non-involved workers were evaluated at a distance of 820 feet (249.9 meters) from the release point. The same occupational health criteria were used to determine the potential effects to the non-involved workers. Potential effects were determined by comparing SLAB model calculated concentrations with health criteria at the distances of concern. As shown in Table 6.17-12, no worker-related criteria were exceeded for non-involved worker exposures to CO_2 from any of the evaluated accidental releases. Alternatively, H_2S could possibly affect non-involved workers exposed to releases from a pipeline rupture, but not a pipeline puncture or wellhead rupture.

> **Health Effects from Accidental Chemical Releases**
>
> The impacts from accidental chemical releases were estimated by determining the number of people who might experience adverse effects and irreversible adverse effects.
>
> **Adverse Effects:** Any adverse health effects from exposure to a chemical release, ranging from mild and transient effects, such as headache or sweating (associated with lower chemical concentrations) to irreversible (permanent) effects, including death or impaired organ function (associated with higher concentrations).
>
> **Irreversible Adverse Effects:** A subset of adverse effects, irreversible adverse effects are those that generally occur at higher concentrations and are permanent in nature. Irreversible effects may include death, impaired organ function (such as central nervous system damage), and other effects that impair everyday functions.
>
> **Life Threatening Effects:** A subset of irreversible adverse effects where exposures to high concentrations may lead to death.

Accidental releases from the pipeline or wellhead, although expected to be infrequent, could potentially have greater consequences and affect the general public in the vicinity of a release. To determine potential impacts to the public, the CO_2 sequestration risk assessment (Tetra Tech, 2007) evaluated potential effects to the public for accidental releases of gases from the pipelines and wellheads. The CO_2 pipeline failure frequency was calculated based on data contained in the on-line library of the Office of Pipeline Safety (OPS, 2007). Accident data from 1994-2006 indicated that 31 accidents occurred during this time period. DOE categorized the two accidents with the largest CO_2 releases (4,000 barrels and 7,408 barrels) as rupture type releases, and the next four highest releases (772 barrels to 3,600 barrels) as puncture type releases. For comparison, 5 miles (8.0 kilometers) of FutureGen pipeline contains about 6,500 barrels, depending on the pipeline diameter. Assuming the total length of pipeline involved was approximately 1,616 miles (2,600 kilometers) based on data in Gale and Davison (2004), the rupture and puncture failure frequencies were calculated to be 5.9×10^{-5}/(km-yr) and 1.18×10^{-4}/(km-yr), respectively. Puncture failure frequencies are reported in failure events per unit length and time based on data for a particular length of pipeline and period of time.

The pipeline failure frequencies are only one component of the exposure frequency. The total exposure frequency also considered the percent of time the wind was blowing in the direction of the receptor, the percent of time the wind stability was the greatest, and the section of the pipeline that would have to fail to possibly allow the release to reach the exposed population.

The failure frequencies for pipeline ruptures and punctures are calculated as the product of the pipeline length at the site and the failure frequencies presented above (ruptures: 5.92×10^{-5}/km-yr; punctures: 1.18×10^{-4}/km-yr) (Gale and Davison, 2004). The failure rate of wellhead equipment during operation is estimated as 2.02×10^{-5} per well per year based on natural gas injection-well experience from an IEA GHG Study (Papanikolau et al., 2006). These failure frequencies provide the basis for the frequency categories presented in Tables 6.17-12 and Table 6.17-15.

The predicted releases, whether by rupture or puncture are classified as extremely unlikely: the frequencies for ruptures is between 9.9×10^{-3} and 1.1×10^{-2}, the frequency for punctures is between 5.0×10^{-3} and 5.6×10^{-3}, and the frequency for a wellhead rupture 1×10^{-6} to 2×10^{-5}/year. The criteria used to examine potential health effects, including mild and temporary as well as permanent effects are defined in Tables 6.17-7 and 6.17-13. The CO_2 and H_2S exposure durations that could potentially occur for the three types of release scenarios are noted in Table 6.17-14.

Table 6.17-13. Description of Hazard Endpoints for Public Receptors

Hazard Endpoint	Description
RfC	An estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime.
TEEL 1	The maximum concentration in air below which it is believed nearly all individuals could be exposed without experiencing other than mild transient adverse health effects or perceiving a clearly defined objectionable odor.
TEEL 2	The maximum concentration in air below which it is believed nearly all individuals could be exposed without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action.
TEEL 3	The maximum concentration in air below which it is believed nearly all individuals could be exposed without experiencing or developing life-threatening health effects.

RfC = Inhalation Reference Concentration.
TEEL = Temporary Emergency Exposure Limits.
Sources: EPA, 2006a; DOE, 2006.

Table 6.17-14. Hazard Endpoints for Public Receptors

Exposure Time	Gas	Effect Category	Concentration (ppmv)	Hazard Endpoint[1]
Minutes (Pipelines)	CO_2	Adverse effects	30,000	TEEL 1
		Irreversible adverse effects	30,000	TEEL 2
		Life Threatening	40,000	TEEL 3
	H_2S	Adverse effects	0.51	TEEL 1
		Irreversible adverse effects	27	TEEL 2
		Life Threatening	50	TEEL 3
Minutes (Explosions[2])	H_2S	Irreversible adverse effects	41	AEGL 2 (10 minute)
		Life threatening	76	AEGL 3 (10 minute)
	SO_2	Irreversible adverse effects	0.75	AEGL 2 (10 minute)
		Life threatening	42	AEGL 3 (10 minute)[3]
Hours/Days	CO_2	Adverse effects	20,000	Headache, etc.[4,5]
		Life Threatening	70,000	Headache, etc.[4,5,6]
	H_2S	Adverse effects	0.33	AEGL 1 (8 hour)
		Irreversible adverse effects	17	AEGL 2 (8 hour)
		Life Threatening	31	AEGL 3 (8 hour)
Years	CO_2	Adverse effects	40,000	Headache, etc.[4,7]
		Life Threatening	70,000	Headache, etc.[4,6,7]
	H_2S	Irreversible adverse effects	0.0014	RfC

[1] See Tables 6.17-7 and 6.17-13 for descriptions of the TEEL and AEGL endpoints.
[2] Used by Quest, 2006 to evaluate releases from explosions.
[3] Quest, 2006.
[4] EPA, 2000.
[5] Headache and dyspnea with mild exertion.
[6] Unconsciousness and near unconsciousness.
[7] Headache, dizziness, increased blood pressure, and uncomfortable dyspnea.
TEEL = Temporary Emergency Exposure Limits.
AEGL = Acute Exposure Guideline Level.
RfC = Inhalation Reference Concentration.

Simulation models were used to estimate the emission of CO_2 for the aboveground release scenarios when the gas is in a supercritical state. The SLAB model developed by the Lawrence Livermore National Laboratory and approved by U.S. EPA was used to simulate denser-than-air gas releases for both horizontal jet and vertically elevated jet scenarios. The model simulations were conducted for the case with CO_2 at 95 percent and H_2S at 100 parts per million by volume (ppmv). The state of the contained captured gas prior to release is important with respect to temperature, pressure, and the presence of other constituents. Release of CO_2 under pressure would likely cause rapid expansion and then reduction in temperature and pressure, which can result in formation of solid-phase CO_2, as explained in Appendix C-III of the risk assessment (Tetra Tech, 2007). The estimated quantity of solid-phase formed was 26 percent of the volume released; therefore 74 percent of the volume released from a pipeline rupture or puncture was used as input to the SLAB model for computing atmospheric releases of CO_2 and H_2S. Carbon dioxide is heavier than air and subsequent atmospheric transport and dispersion can be substantially affected by the temperature and density state of the initially released CO_2. The meteorological conditions at the time of the release would also affect the behavior and potential hazard of such a release.

The potential effects of CO_2 and H_2S releases from pipeline ruptures and punctures were evaluated using an automated "pipeline-walk" analysis. The methodology (described briefly in Appendix D and in detail in Section 4.4.2 and Appendix C-IV of the risk assessment) estimates the maximum expected number of individuals from the general public potentially affected by pipeline ruptures or punctures at each site. The analysis takes into account the effects of variable meteorological conditions and the location of pipeline ruptures or punctures. For wellhead ruptures the potential impact zones corresponding to health-effects criterion values for H_2S and CO_2 were determined using the SLAB model and assuming meteorological conditions that resulted in the highest potential chemical exposures (i.e., assuming wind speeds of 2 meters per second and stable atmospheric conditions). The number of individuals potentially affected within the impact zone was determined from population data obtained from the 2000 U.S. Census.

This modeling approach to assess potential chemical exposures is based on the assumption that the population size and locations near the proposed project would not change during the time period assessed for this proposed project (i.e., 50 years for releases during the operation phase and 5,000 years for releases of sequestered gases).

Among the three types of accidental releases, the postulated accident that would result in the largest number of people with adverse health effects (including mild and temporary as well as permanent effects) is a pipeline rupture 3 miles (4.8 kilometers) east of where segment F-H crosses the Trinity River. If this type of accident occurred along this segment, it is estimated that up to 52 members of the general public might experience adverse effects, primarily from H_2S exposure (mild and temporary effects, such as headaches or exhaustion) (see Table 6.17-15). A pipeline puncture at this location could cause adverse effects to one member of the general public. Since the pipeline would extend approximately 52 to 59 miles (84 to 95 kilometers) from the proposed power plant to the injection wellheads (FG Alliance, 2006c), more of the public are likely to be affected than workers at the proposed power plant.

The postulated accident that would cause irreversible health effects to the largest number of individuals is a pipeline rupture. It is calculated that one member of the general public might experience irreversible adverse effects (e.g., poor memory or poor attention span) or life-threatening effects.

As shown in Table 6.17-15, the number of individuals in the general public potentially with adverse effects from other types of accidents would be less, with four affected by a wellhead rupture. No fatalities were projected for a pipeline puncture or wellhead rupture.

Although the potential for releases from pipelines or wellheads may be low, any releases from the pipeline or wellheads could be high consequence events. For this reason, there are well-established measures for preventing or reducing impacts of accidental releases. These include design recommendations (e.g., increasing pipeline wall thickness, armoring pipelines in specific locations such as water body and road crossings); use of newer continuous pipeline monitors and computer models to rapidly interpret changes in fluid densities, pressures, etc.; use of safety check valves at closer intervals (e.g., 1 to 3 miles [1.6 to 4.8 kilometers] instead of 5 miles [8 kilometers] in populated areas) that can quickly isolate damaged section of the pipeline; operational procedures (e.g., activating "bleed" valves to control location and direction of releases should a puncture occur); and emergency response procedures (e.g., notifying the public of events requiring evacuation). In high consequence areas such as areas with high population densities, the pipeline could be buried at a deeper depth, valves could be buried in underground vaults, and the pipeline and wellhead locations could be marked and protected with chain link fences and posts. The pipeline could be routed to maximize the distance to sensitive receptors and to allow a buffer between the pipeline and the nearest residence or business. In some cases it may be possible to further reduce the concentrations of effect-causing substances being transported (e.g., H_2S). These measures would be implemented, as appropriate.

Risk Screening Results for Post-sequestration Conditions

Under post-sequestration conditions, a slow continuous leak through a deep well was determined to be the only scenario that may cause adverse health effects to the general public (Tetra Tech, 2007). Since the deep wells within the vicinity of the proposed CO_2 injection wells would be properly sealed before initiation of CO_2 sequestration, and since the proposed CO_2 injection well(s) would also be properly sealed after their use, it is extremely unlikely that the proposed project would create a gas release of consequence from the subsurface (Table 6.17-16). However, if this type of release occurred at the proposed sequestration site, it is estimated that up to 26 members of the public might experience irreversible adverse effects from H_2S exposures (i.e., nasal lesions). This estimate is based on the assumption that the future population would be the same as current conditions. Also, this evaluation is based on the EPA RfC criterion for chronic (i.e., long-term and low level) exposures that incorporates a safety factor of 300 to be protective of sensitive individuals. The RfC criterion value for H_2S is an extremely low concentration: 0.0014 ppm.

Since CO_2 sequestration is a relatively new technology, a series of mitigation and monitoring measures have been developed for these activities. In addition to plugging and properly abandoning wells, monitoring plans include use of remote sensing methods, atmospheric monitoring techniques, methods for monitoring gas concentrations in the subsurface and surface environments, and processes for monitoring subsurface phenomena associated with the injection reservoir and the caprock (FG Alliance, 2006a-d). A specific schedule for different types of monitoring has been proposed for the proposed Jewett Sequestration Site and surrounding areas that would occur before and during sequestration activities (FG Alliance, 2006c). Also, after the cessation of injection monitoring, activities would be used to identify any long-term, post-closure changes in land surface conformation, soil gas, and atmospheric fluxes of CO_2.

Table 6.17-15. Effects to the Public from Pre-Sequestration Releases

Release Scenario	Frequency Category[2]	Gas	Effect[3]	Distance (ft [meter])	Number Affected
Pipeline Rupture[1] (release duration = minutes)	U	CO_2	Adverse Effects	663 (202)	0
			Irreversible Adverse	663 (202)	0
			Life Threatening	216 (66)	0
		H_2S	Adverse Effects	22,588 (6,885)	52
			Irreversible Adverse	1,945 (593)	1
			Life Threatening	1,224 (373)	1
Pipeline Puncture (release duration = approximately 4 hours)	L-U	CO_2	Adverse Effects	551 (168)	<1
			Life Threatening	115 (35)	<1
		H_2S	Adverse Effects	5,712 (1,741)	6
			Irreversible Adverse	551 (168)	0
			Life Threatening	377 (115)	0
Wellhead Equipment Rupture (Travis Peak) (release duration = minutes)	EU	CO_2	Adverse Effects	26 (7.9)	0
			Irreversible Adverse	26 (7.9)	0
			Life Threatening	20 (6.1)	0
		H_2S	Adverse Effects	2,585 (787.9)	0
			Irreversible Adverse	269 (82.0)	0
			Life Threatening	174 (53.0)	0
Wellhead Equipment Rupture (Woodbine) (release duration = minutes)	EU	CO_2	Adverse Effects	10 (3.0)	0
			Irreversible Adverse	10 (3.0)	0
			Life Threatening	7 (2.1)	0
		H_2S	Adverse Effects	1,752 (534.0)	0
			Irreversible Adverse	161 (49.1)	0
			Life Threatening	98 (29.9)	0
Wellhead Equipment Rupture (TDCJ) (release duration = minutes)	EU	CO_2	Adverse Effects	10 (3.0)	0
			Irreversible Adverse	10 (3.0)	0
			Life Threatening	7 (2.1)	0
		H_2S	Adverse Effects	1,752 (534.0)	4
			Irreversible Adverse	161 (49.1)	0
			Life Threatening	98 (29.9)	0

[1] Rupture assumed to occur at the juncture of pipeline segments C&D, west of Buffalo, Texas.
[2] U(unlikely)=frequency of 1x 10^{-2}/yr to 1x 10^{-4}/yr; L (likely) = frequency of > or equal to 1x 10^{-2}/yr; EU(extremely unlikely)=frequency of 1x10^{-4}/yr to 1x10^{-6}/yr.
[3] See Section 6.17.4.2 for an explanation of the effects categories.

Table 6.17-16. Number of Individuals with Adverse Effects from Potential Exposure to Post-Sequestration H_2S Gas Releases

Release Scenario	Frequency Category[1]	Number Affected[2]
Upward slow leakage through CO_2 injection well	EU	
Travis Peak		0.4
Woodbine		0.4
TDCJ		26
Upward slow leakage through deep oil and gas wells	EU[3]	
Travis Peak and Woodbine		0.4
TDCJ		26
Upward slow leakage through other existing wells	EU[3]	
Travis Peak and Woodbine		0.4
TDCJ		26

[1] EU(extremely unlikely)=frequency of $1x10^{-4}$/yr to $1x10^{-6}$/yr.
[2] Potentially irreversible adverse effects could occur within 745 feet of the release point; instances presented here are converted from meters, which were used in the risk assessment (see Appendix D). Also, assumed future population density would remain the same as current conditions, with the Coffield State Prison Farm on the periphery of the sequestration plume footprint.
[3] Assumes that the other wells potentially within the sequestration plume footprint have been properly sealed before sequestration begins.
TDCJ = Texas Department of Criminal Justice.

6.17.5 TERRORISM/SABOTAGE IMPACT

As with any U.S. energy infrastructure, the proposed power plant could potentially be the target of terrorist attacks or sabotage. In light of two recent decisions by the U.S. Ninth District Court of Appeals (*San Luis Obispo Mothers v. NRC, Ninth District Court of Appeals, June 2, 2006; Tri Valley Cares v. DOE, No. 04-17232, D.C. No. CV-03-03926-SBA, October 16, 2006),* DOE has examined potential environmental impacts from acts of terrorism or sabotage against the facilities being proposed in this EIS.

Although risks of sabotage or terrorism cannot be quantified because the probability of an attack is not known, the potential environmental effects of an attack can be estimated. Such effects may include localized impacts from releases from the proposed power plant and associated facilities, assuming that such releases would be similar to what would occur under an accident or natural disaster (such as a tornado). To evaluate the potential impacts of sabotage/terrorism, failure scenarios are analyzed without specifically identifying the cause of failure mechanism. For example, a truck running over a wellhead at the proposed sequestration site would result in a wellhead failure, regardless of whether this was done intentionally or through mishap. Therefore, the accident analysis evaluates the outcome of catastrophic events without determining the motivation behind the incident. The accident analyses evaluated potential releases from pipelines, wellheads, and major and minor system failures/accidents at the proposed power plant site. These accidents could also be representative of the impacts from a sabotage or terrorism event.

Various release scenarios were evaluated including: pipeline rupture, pipeline puncture, and wellhead equipment rupture. Gaseous emissions were assumed to be 95 percent CO_2 and 0.01 percent H_2S. Table 6.17-15 provides effects levels for individuals of the public that could potentially be exposed to releases. Of these release scenarios at the proposed Jewett Site, a pipeline rupture would result in impacts to the public over the largest distance. For a release of the CO_2 gas from a pipeline rupture, no impacts from CO_2 would occur beyond 0.1 mile (0.2 kilometer) of the release, while impacts from the H_2S in the gas stream could occur within 0.4 mile (0.6 kilometer) of the release, tapering to no impact at a distance of

4.3 miles (6.9 kilometers). Under upperbound conditions such a release could cause up to one fatality and adverse health effects to 52 individuals.

For short-term CO_2 and H_2S co-sequestration testing over the two non-consecutive one-week test periods, the concentration of H_2S in the sequestered gas would be 2 percent (20,000 ppmv) or 200 times greater than the base case, which assumed the H_2S concentration would be 100 ppmv. Because these tests would occur for a very short period of time (a total of two weeks), it would be very unlikely that an accidental release would occur during co-sequestration testing. Nevertheless, additional model simulations of pipeline ruptures or punctures to represent releases during the co-sequestration experiment were conducted, as discussed in Section 4.5.5 of the Final Risk Assessment Report. These results show that the distance downwind where the public could be exposed to H_2S at levels that could result in adverse effects are significantly greater than for the base case, and thus more people could be exposed, if a release occurred during an experiment. While the distances where adverse effects occur, as listed in the Risk Assessment, are quite high (tens of miles), they are likely greatly overestimated in the model, as it assumes that the wind would be maintained at the same stability class, wind speed and direction over a substantial amount of time (e.g., 19 hours for Jewett). Although short-term testing of co-sequestration (CO_2 with H_2S) may be considered for two weeks during the DOE-sponsored phase of the proposed project, no decision has been made yet to pursue the co-sequestration testing, and further NEPA review may be required before such tests could be conducted. If co-sequestration would be considered for a longer period of time under DOE funding, further NEPA review would be required. To minimize the potential for releases during the co-sequestration experiments, additional protective measures could be implemented, including inspection of the pipeline before and after the tests and not allowing any excavation along the pipeline route during the tests.

In general, ruptures or punctures of pipelines are rare events. Based on OPS nationwide statistics, 31 CO_2 pipeline accidents occurred between 1994 and 2006. None of these reported accidents were fatal nor caused injuries (OPS, 2006). Should a CO_2 pipeline rupture occur, it would be immediately detected by the pipeline monitoring system, alerting the pipeline operator. Once the flow of gas has stopped, the gas would dissipate and chemical concentrations at the source of the release would decline to non-hazardous levels in a matter of minutes for a pipeline rupture and several hours for a pipeline puncture. However, the released gas then migrates downwind, as described in the preceding sections.

The potential health effects from "upperbound" explosion and release scenarios at the proposed power plant (Section 6.17.3.2) can be contrasted with those associated with the pipeline. Hazardous events evaluated for the proposed power plant included: gas releases and exposure to toxic gas clouds, flash fires, torch fires, and vapor cloud explosions. Evaluations of these results indicate:

- Toxic releases from the Claus unit that could extend from 0.2 to 1.4 miles (0.3 to 2.3 kilometers) from the point of release (Quest, 2006). Based on aerial photographs of the region, there are no family residences or farm homes within the maximum distance potentially impacted by releases from the Claus unit (i.e., 1.4 miles [2.3 kilometers] of the site) under current conditions (Quest, 2006). However, examination of population density estimates (see Section 6.17.4.2) suggests that such releases could potentially cause irreversible adverse effects in 1820 individuals exposed to SO_2, with five exposed to potentially life threatening concentrations of H_2S (Table 6.17-17). These results may, at least partially, be based on the observation that portions of the Limestone Generating Station and the Jewett Mine properties are within this release footprint (Quest, 2006). The total number of workers potentially affected by these releases is not certain, although 373 workers are reportedly employed at the Jewett Mine (Texas Westmoreland Coal Co., 2005).
- Toxic releases from the gasifier could extend from 0.2 to 0.6 mile (0.3 to 1.0 kilometer) from the point of release (Quest, 2006). Based on aerial photographs of the region, there are no family residences, farm homes or commercial properties within this release footprint radius (Quest, 2006). However, examination of the population density estimates suggests that such a release

could potentially cause irreversible adverse effects in 17 individuals exposed to CO, with two exposed to potentially life-threatening effects.

- Fire hazards at the plant site would not extend off site.
- Under all worst case scenarios, plant workers would be the most at-risk of injury or death.

Table 6.17-17. Effects to the Public from Explosions at the FutureGen Plant

Release Scenario	Gas	Effect[1]	Distance[2] (miles [kilometers])	Number Affected
Claus Unit failure (release duration = minutes)	H_2S	Irreversible adverse effects	0.5 (0.8)	12
		Life threatening	0.4 (0.6)	5
	SO_2	Irreversible adverse effects	1.4 (2.3)	92
		Life threatening	0.2 (0.3)	2
Gasifier release (release duration = minutes)	CO	Irreversible adverse effects	0.6 (1.0)	17
		Life threatening	0.2 (0.3)	2

[1] See Table 6.17-3 for an explanation of the effects.
[2] Distances taken from Quest, 2006.

As discussed, if an explosion occurred at the proposed plant site as the result of a terrorist attack, it is likely that hazardous gases would cause injury and death of workers within the proposed plant site and most likely the public located within 1.4 miles (2.2 kilometers) of the proposed plant site.

6.18 COMMUNITY SERVICES

6.18.1 INTRODUCTION

This section identifies the community services most likely to be affected by the construction and operation of the proposed FutureGen Project at the Jewett Power Plant Site in Freestone, Leon, and Limestone counties in Texas. This section addresses law enforcement, fire protection, emergency response, health care services, and the school system. Additionally, the potential effects that the construction and operation of the proposed FutureGen Project could have on those services, as well as any proposed mitigation measures that could reduce any adverse effects, are discussed.

6.18.1.1 Region of Influence

The ROI for community services includes the land area within 50 miles (80.5 kilometers) of the boundaries of the proposed power plant site and sequestration site. The proposed sequestration site is located approximately 33 miles (53.1 kilometers) northeast of the proposed plant site. As shown in Figure 6.18-1, the 50-mile (80.5-kilometer) radius for the sequestration site and the 50-mile (80.5-kilometer) radius for the plant site largely overlap. The ROI for the proposed Jewett Power Plant Site and Sequestration Site includes all land area in Freestone County and some land area in the counties of Leon, Limestone, Anderson, Brazos, Falls, Houston, Madison, McLennan, Navarro and Robertson.

Community services data are reported county-wide because this format is most often used in public information. This includes counties that have only a relatively small portion of land lying within the 50-mile (80.5-kilometer) radius. Therefore, if only a minor portion of a county was touched by the 50-mile (80.5-kilometer) radius and two or fewer small communities fall within that minor portion of the county, then that county was excluded from the analysis as not materially affecting the aggregate community services in the ROI. Those counties with two or fewer small communities that were excluded from the ROI include Cherokee, Grimes, Henderson, Hill, Kaufman, Milam, Smith, Van Zandt, and Walker. Excluding these counties from the ROI makes the remaining data more meaningful for determining project effects.

Although the analysis in this section addresses the entire ROI, the affected environment and environmental consequences focus on the proposed power plant site located in Freestone, Leon and Limestone counties.

6.18.1.2 Method of Analysis

DOE evaluated the impacts to community services based on anticipated changes in demand for law enforcement, fire protection, emergency response, health care services, and schools using research provided in the Jewett EIV (FG Alliance, 2006c). In many cases, the change in demand would be directly related to the increased population.

DOE assessed the potential for impacts based on the following criteria:

- Affect on law enforcement;
- Conflict with local or regional management plans for law enforcement;
- Affect on fire protection;
- Conflict with local or regional management plans for fire protection;
- Affect on emergency response;
- Conflict with local or regional management plans for emergency response;

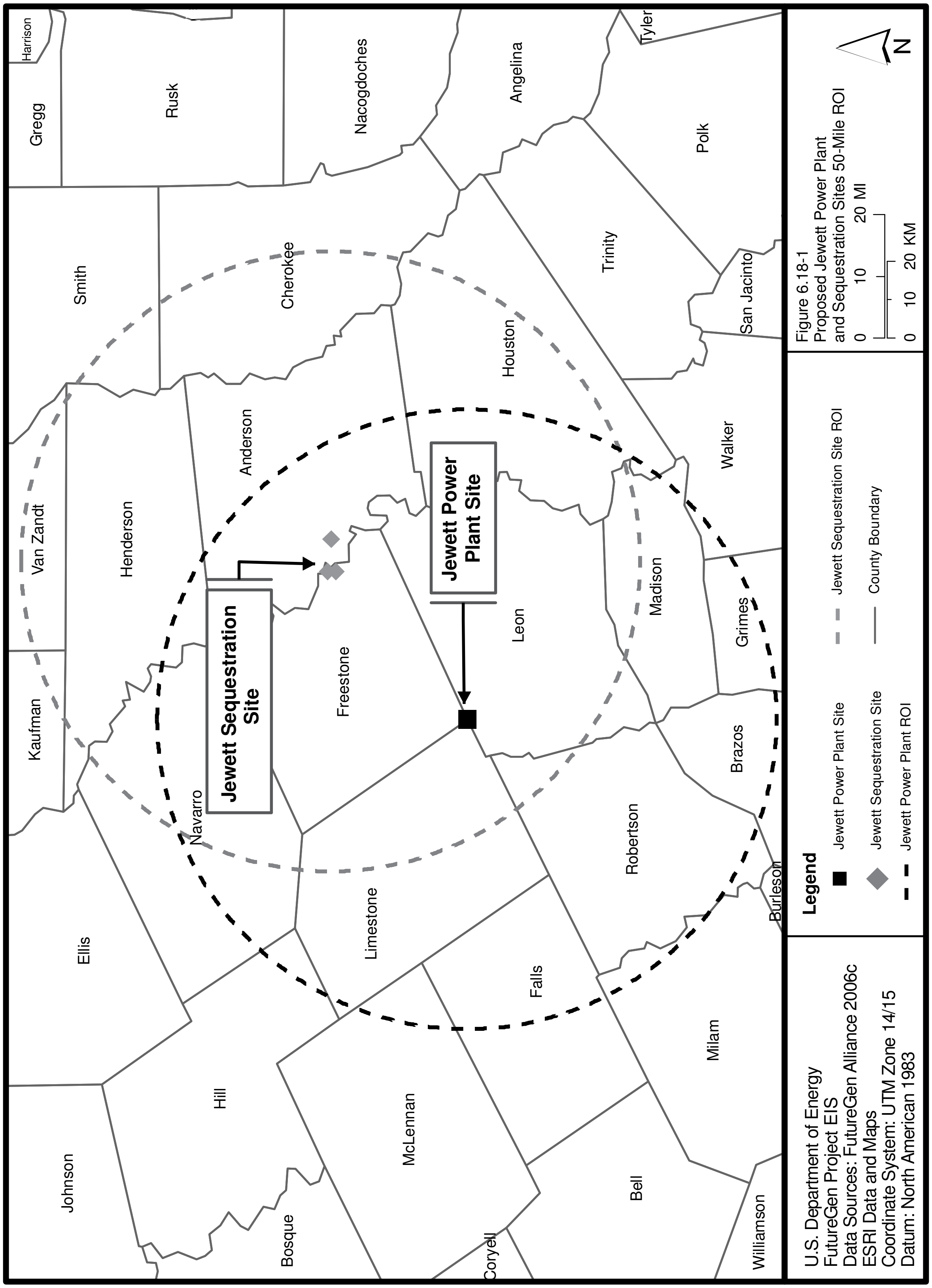

Figure 6.18-1
Proposed Jewett Power Plant and Sequestration Sites 50-Mile ROI

- Affect on health care services;
- Conflict with local or regional management plans for health care services;
- Affect on local schools; and
- Conflict with local or regional management plans for schools.

6.18.2 AFFECTED ENVIRONMENT

6.18.2.1 Law Enforcement

Freestone, Leon, and Limestone counties are served by eight municipal police departments located in Fairfield, Teague, Wortham, Buffalo, Jewett, Groesbeck and Mexia (UC, 2005 and FG Alliance, 2006c). Table 6.18-1 presents staffing levels of these police departments. A total of 67 officers work out of these eight departments in Freestone, Leon and Limestone counties, and each county in Texas is served by its own County Sheriff's Office (FG Alliance, 2006c; UC, 2005; and CD, 2002).

Anderson, Brazos, Falls, Houston, Madison, McLennan, Navarro and Robertson counties in Texas are served by a total of 24 municipal police departments (UC, 2005).

Table 6.18-1. Staffing Levels of Police Departments in Freestone, Leon, and Limestone Counties

County	Number of Police Officers
Freestone	27
Leon	12
Limestone	28
Total	**67**

Source: FG Alliance, 2006c and CD, 2002.

The U.S. has an average of 2.3 police officers per thousand residents (Quinlivan, 2003). In Freestone, Leon and Limestone counties, the ratio is approximately 1.1 officers per thousand residents based on the 2005 projected population and 67 full-time law enforcement officers. Although the ratio of officers is well below the national average, crime in Freestone, Leon and Limestone counties is extremely low. Index offenses, which include criminal sexual assault, robbery, aggravated assault, burglary, theft, motor vehicle theft and arson, are a way of measuring and comparing crime statistics (TDPS, 2003). The State of Texas averaged 5,153 index offenses per 100,000 residents in 2003, whereas Freestone, Leon and Limestone counties averaged 429 index offenses per 100,000 residents for the same year (TDPS, 2003).

6.18.2.2 Emergency and Disaster Response

In Texas, Councils of Government are organizations of local county governments working together to solve mutual community problems. Emergency response and fire protection are managed by the Councils of Government because Texas counties can be very rural and cover large land areas that can be more effectively served at a regional level. Freestone and Limestone counties are members of the Heart of Texas Council of Government's organization of 911 public safety answering points and, similarly, Leon County is served by the Brazos Valley Council of Government. These organizations oversee 911 emergency management and dispatch fire and rescue, ambulances and emergency medical personnel from the answering points located throughout its member counties. The ROI is served by 29 emergency medical and ambulance services, and four air ambulance services (FG Alliance, 2006c).

6.18.2.3 Fire Protection

Freestone, Leon and Limestone counties host a total of 32 fire departments with trained fire services personnel. The proposed Jewett Power Plant Site and Sequestration Site would be served by a total of 84 fire departments from within the Heart of Texas and Brazos Valley Councils of Government. As of May 2006, the State of Texas was in the process of developing a statewide mutual aid system (TFCA, 2006). The system, if implemented, would provide a mechanism for fire protection and emergency response assistance in case of a major emergency from organizations throughout the State of Texas.

6.18.2.4 Hazardous Materials Emergency Response

The proposed Jewett Power Plant Site and sequestration site would be served by two Hazardous Materials (HazMat) units located in Brazos and Limestone counties. HazMat units respond and perform functions to handle and control actual or potential leaks or spills of hazardous substances (OSHA, 1994).

6.18.2.5 Health Care Service

A total of 26 hospitals and medical clinics serve the ROI (FG Alliance, 2006c). Freestone, Leon and Limestone Counties are served by three hospitals and two medical clinics, which include East Medical Center in Fairfield, Limestone Medical Center in Groesbeck, Parkview Regional Hospital in Mexia, Leon Health Resource Center in Centerville, and St. Joseph-Normangee Family Health Center in Normangee. There are approximately 1,605 beds in the 26 hospitals in the ROI. Based on the 2005 total projected population, there are 2.6 beds per thousand people within the ROI.

6.18.2.6 Local School System

Freestone, Leon, and Limestone counties have 12 elementary schools, seven junior high schools, 11 high schools, four specialty schools, and as many as 12 private schools (FG Alliance, 2006c and TEA, 2005). Table 6.18-2 indicates the expenditure per pupil per school year and the student-teacher ratio for the State of Texas and the U.S in 2005.

Table 6.18-2. School Statistics for Texas and the U.S. in 2005

	Expenditure Per Pupil Per School Year ($)	Pupils Per Teacher (Elementary/Secondary)
Texas	7,142	14.9/14.9
Nationwide	8,287	15.4/15.4

Source: CPA, 2006; USCB, 2006; and NCES, 2005.

6.18.3 IMPACTS

6.18.3.1 Construction Impacts

As discussed in Section 6.19, the need for construction workers would be limited in duration, but would likely cause an influx of temporary residents. Construction workers could be drawn from a large labor pool within the ROI; however, some temporary construction workers with specialized training and workers employed by contractors from outside the ROI would also likely be employed to construct the facilities. Some of these workers would be expected to commute to the construction site on a daily or weekly basis, while others would relocate to the area for the duration of the construction period.

Law Enforcement

The temporary construction jobs created by the proposed FutureGen Project could cause an influx of temporary residents to the communities within the ROI. The increased temporary population could affect the working capacities of individual local police departments, depending on where the workers chose to reside. The affected locations would depend on the degree to which the construction workers would be dispersed throughout the communities within the ROI. As discussed in Section 6.19, temporary construction workers would likely reside in short-term housing. Freestone, Leon and Limestone counties do not have enough hotel rooms, when occupancy rates are taken into account, to accommodate all of the temporary workers (FG Alliance, 2006c). Therefore, it is anticipated that the availability of local lodging would effectively disperse workers throughout communities within the ROI and law enforcement would not be affected.

The population in the ROI is expected to grow on average by 12.1 percent, or approximately 71,653 people, by 2010 (FG Alliance, 2006c). Additional police and other law enforcement services would be required to accommodate the growing population, especially in Brazos, Freestone, and Navarro counties, which have the highest projected growth rates. Although the number of law enforcement officers is below the U.S. average, county crime rates are extremely low, which is an indication that law enforcement is appropriately staffed (FG Alliance, 2006c; CD, 2002; and Quinlivan, 2003). The number of construction workers and their families who would temporarily relocate to the area for the proposed project is unknown, but any additional population is not anticipated to create a permanent unsustainable increase in the demand for law enforcement.

Construction activities would not impede effective law enforcement or conflict with regional plans.

Fire Protection

As discussed in Section 6.17, construction of the proposed facility would involve the use of flammable and combustible materials that pose an overall increase in risk of fire or explosion at the project site. However, the probability of a significant fire or explosion during construction of the proposed project is low. Incidents during construction of the proposed facilities would not increase the demand for fire protection services beyond the available capacity of currently existing services. Texas fire departments would have the capacity to respond to a major fire emergency at the proposed power plant site and sequestration site. Currently, 84 fire departments are located within the Heart of Texas and Brazos Valley Councils of Government. Any of these fire departments would be available to assist in a fire emergency if needed.

Emergency and Disaster Response

As discussed in Section 6.17, it is anticipated that construction of the proposed facilities would result in an average of 19.6 total recordable injury cases per year with a peak maximum of 39.2 total recordable injury cases per year. Based on the number of emergency response organizations, the proposed power plant site and sequestration site would be adequately served in an emergency. Freestone, Leon and Limestone counties and the entire ROI are served by 29 ambulance services and four air ambulance services. Emergencies during construction of the proposed facilities would not be expected to increase the demand for emergency services beyond current available capacity. While it is not anticipated that actual conflicts would arise, the nature and timing of accidents could result in an increased response time when there are other accidents in the area, thereby increasing the demand for emergency services.

Health Care Service

The 350 to 700 temporary construction jobs created by the proposed FutureGen Project could cause an influx of temporary residents to the communities within the ROI. Currently, the ROI has a health care capacity that is less than the national average, with 2.6 hospital beds per thousand residents. The U.S. average is 2.9 hospital beds per thousand residents. However, even if all 700 temporary workers relocated within the ROI, the reduction in health care capacity would be extremely small. The ratio of hospital beds per thousand residents would remain at approximately 2.6 and, therefore, no impacts are expected.

The **Hill-Burton Act of 1946** established the objective standard for the number of hospitals, beds, types of beds, and medical personnel needed for every 1,000 people, by county (Everett, 2004). It called for states to "afford the necessary physical facilities for furnishing adequate hospital, clinic, and similar services to all their people." The Hill-Burton standard is 4.5 beds per thousand residents (Everett, 2004). However, the U.S. average in 2001 was 2.9 beds per thousand residents, which is about 24 percent fewer beds per thousand residents than the current ratio within the ROI (Everett and Baker, 2004).

Local School System

Although some portion of the temporary construction workers may relocate to the ROI with their families, a large influx of school-aged children would not be anticipated. Because construction of the proposed facilities would create temporary work, it is unlikely that the construction workers would relocate with their families. It is more likely that temporary workers, who permanently reside outside of the ROI, would seek short-term housing for themselves during the work week. As a result, any influx of school-aged children would result in a minimal impact to local schools and their resources.

Project construction would not displace existing school facilities or conflict with school system plans.

6.18.3.2 Operational Impacts

As discussed in Section 6.19, the operational phase of the proposed facilities would require approximately 200 permanent staff. Although the exact number of permanent staff who would relocate to the ROI is unknown, the increase in population would be very small, even if all 200 positions were filled by staff relocating to the ROI. Based on the 2005 projected population and the average family size within the ROI, the relocation of 200 workers would result in a population increase of 612 people, representing a 0.1 percent increase in population within the ROI.

Law Enforcement

Law enforcement in the ROI would be sufficient to handle the 0.1 percent increase in population during facility operation. A 0.1 percent increase in population in Freestone, Leon and Limestone counties would result in an imperceptibly small decrease, less than 0.02, in the ratio of law enforcement officers per thousand residents. In addition, the average crime rate in Freestone, Leon, and Limestone counties, which is consistent with crime rates in rural communities in Texas, is well below the national average. This is an indication that law enforcement is appropriately staffed and would be sufficient to handle a minor increase in population.

Project operation would not impede effective law enforcement or conflict with regional plans.

Fire Protection

As discussed in Section 6.17, operation of the proposed power plant would involve the use of flammable and combustible materials that pose an overall increase to risk of fire or explosion at the project site. However, the probability of a significant fire or explosion during operation of the proposed project is low. Incidents during the operational phase of the proposed facilities would not increase the demand for fire protection services beyond the available capacity of currently existing services. Texas fire departments would have the capacity to respond to a major fire emergency at the proposed power plant site. There are currently 84 fire departments within the Heart of Texas and Brazos Valley Councils of Government. Any of these fire departments could assist in a fire emergency if needed.

Emergency and Disaster Response

As indicated in Section 6.17, it is anticipated that the operational phase of the proposed facilities would result in an average of 6.6 total recordable injury cases per year. Based on the number of emergency response organizations, the proposed power plant site and sequestration site would be adequately served in an emergency. Freestone, Leon and Limestone counties and the entire ROI are served by 29 ambulance services and four air ambulance services. Emergencies during construction of the proposed facilities would not be expected to increase the demand for emergency services beyond the existing available capacity. While it is not anticipated that actual conflicts would arise, the nature and timing of accidents could result in an increased response time when there are other accidents in the area, thereby increasing the demand for emergency services.

Health Care Service

It is anticipated that the 200 permanent jobs created by FutureGen Project operations could cause an influx of permanent residents to the communities within the ROI. This influx would result in an increase in population of 0.1 percent, representing approximately 612 new residents. The ROI currently has a health care capacity that is less than the national average, with 2.6 hospital beds per thousand residents. The U.S. average is 2.9 hospital beds per thousand residents. Although the proposed project would increase the number of residents requiring medical care, the reduction in health care capacity would be extremely small. The ratio of hospital beds per thousand residents would remain at approximately 2.6 and, therefore, no impacts are expected.

Local School System

While the actual number of the 200 permanent staff who would relocate to the ROI with their families to work at the facility is unknown, based on the average family size and the percent of school-aged children in the population, it can be estimated that a maximum of 170 new school-aged children could relocate within the ROI (FG Alliance, 2006c). The 2005 public school enrollment for the counties within the ROI was 76,168 for kindergarten through 12th grade (FG Alliance, 2006c). An additional 170 new school-aged children would represent a 0.2 percent increase in the number of students who would share the current schools' resources.

Project operation would not displace existing school facilities or conflict with school system plans.

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6.19 SOCIOECONOMICS

6.19.1 INTRODUCTION

This section addresses the region's socioeconomic resources most likely to be affected by the construction and operation of the proposed FutureGen Project. This section discusses the region's demographics, economy, sales and tax revenues, per capita and household incomes, sources of income, housing availability, and the potential effects that the construction and operation of the proposed project could have on socioeconomics.

6.19.1.1 Region of Influence

The ROI for socioeconomics includes the land area within 50 miles (80.5 kilometers) of the boundaries of the proposed power plant site, sequestration site, and utility and transportation corridors. As shown in Figure 6.18-1, the ROI for the proposed FutureGen Project includes all land area in Freestone County and some land area in Leon, Limestone, Anderson, Brazos, Falls, Houston, Madison, McLennan, Navarro, and Robertson counties. Therefore, this section focuses on the socioeconomic environment at the county level rather than by the proposed sites and utility and transportation corridors.

A few counties have a relatively small portion of land within the ROI and were, therefore, excluded from the analysis as not materially affecting the aggregate socioeconomics of the ROI. Cherokee, Grimes, Henderson, Hill, Kaufman, Milam, Smith, Van Zandt, and Walker counties contain no more than two small communities and were also excluded from the ROI. Although the analysis addresses the entire ROI, the affected environment and environmental consequences focus more on the proposed power plant site located in Freestone, Leon, and Limestone counties.

6.19.1.2 Method of Analysis

DOE reviewed U.S. Census data, the Alliance EIVs, and other information to determine the potential for impacts based on whether the proposed FutureGen Project would:

- Displace existing population or demolish existing housing;
- Alter projected rates of population growth;
- Affect the housing market;
- Displace existing businesses;
- Affect local businesses and the economy;
- Displace existing jobs; and
- Affect local employment or the workforce.

6.19.2 AFFECTED ENVIRONMENT

6.19.2.1 Regional Demographics and Projected Growth

The regional demographics for the ROI are provided in Table 6.19-1. In 2000, the total population for the counties within the ROI was 592,119 (FG Alliance, 2006c). The total population for the ROI is anticipated to increase by approximately 12.1 percent by 2010 to 663,772 (FG Alliance, 2006c).

The 2000 Texas population was 20,851,820 and is anticipated to increase by 9.4 percent by 2010 to 22,802,947 (USCB, 2000a). The 2000 U.S. population was 282,125,000 and is anticipated to increase by approximately 9.5 percent by 2010 to 308,936,000 (USCB, 2005a). Thus, the ROI is anticipated to grow at a faster rate than the U.S. and Texas (FG Alliance, 2006c). Freestone, Leon, and Limestone counties had a combined population of 55,253 in 2000 (FG Alliance, 2006c). Within the ROI, Freestone, Leon, and Limestone counties account for 9.3 percent of the total population. The growth in these counties is anticipated to average 15.1 percent from 2000 to 2010, which is higher than the ROI's expected average growth. The median age of residents in 2000 was 35.3 years for the U.S., 32.3 years for Texas, and 39.1 years in Freestone, Leon, and Limestone counties (USCB, 2000b and USCB, 2000c).

Table 6.19-1. Population Distribution and Projected Change for Counties Containing Land Area Within the ROI

County	Year 2000					2010 Projected Total Population	Projected Change 2000 to 2010 (percent)
	Total	Under 18	18-64	65 and over	Average Family Size		
Freestone	17,867	4,683	10,252	2,932	3.0	20,906	3,039 (17.0)
Leon	15,335	4,074	8,191	3,070	3.0	17,737	2,402 (15.7)
Limestone	22,051	6,149	12,288	3,614	3.0	24,809	2,758 (12.5)
Anderson	55,109	12,650	36,027	6,432	3.1	59,439	4,330 (7.9)
Brazos	152,415	46,689	95,503	10,223	3.2	178,714	26,299 (17.3)
Falls	18,576	5,676	9,767	3,133	3.2	20,098	1,522 (8.2)
Houston	23,185	5,963	13,055	4,167	3.0	24,371	1,186 (5.1)
Madison	12,940	3,031	8,103	1,806	3.1	14,075	1,135 (8.8)
McLennan	213,517	56,830	129,238	27,449	3.1	232,648	19,131 (9.0)
Navarro	45,124	13,969	24,668	6,487	3.1	53,311	8,187 (18.1)
Robertson	16,000	4,911	8,374	2,715	3.1	17,664	1,664 (10.4)
Total or Average	**592,119**	**164,625**	**355,466**	**72,028**	**3.1**	**663,772**	**71,653 (12.1)**
Texas	**20,851,820**					**22,802,947**	**1,951,127 (9.4)**
U.S.	**282,125,000**					**308,936,000**	**2,681,000 (9.5)**

Source: FG Alliance, 2006c.

6.19.2.2 Regional Economy

Income and Unemployment

Table 6.19-2 provides information about the workforce, and per capita and median household incomes for the counties located within the ROI. In July 2006, 19,542 persons were unemployed within the ROI and the average unemployment rate was 5.8 percent (FG Alliance, 2006c). In the same year, Freestone, Leon, and Limestone counties had a lower average unemployment rate of 5.1 percent (FG Alliance, 2006c). In July 2005, the average unemployment rate in the U.S. was 4.8 percent and 5.2 percent for Texas (USBLS, 2006a and USBLS, 2006b). Thus, Freestone, Leon, and Limestone counties and the ROI have an unemployment rate consistent with the average Texas rate and higher than the U.S. average.

Table 6.19-2. Employment and Income for Counties Within the ROI

County	Employment		Income	
	Total Employed (2004)	Unemployment Rate (July 2006) (percent)	1999 Per Capita Income	1999 Median Household Income
Freestone	10,156	4.4	$16,338	$31,283
Leon	9,141	5.7	$17,599	$30,981
Limestone	11,724	5.3	$14,352	$29,366
Anderson	25,665	6.7	$13,838	$31,957
Brazos	95,853	4.4	$16,212	$29,104
Falls	8,199	7.1	$14,311	$26,589
Houston	11,531	6.6	$14,525	$28,119
Madison	6,023	6.1	$14,056	$29,418
McLennan	127,050	5.4	$17,174	$33,560
Navarro	24,391	6.0	$15,266	$31,268
Robertson	7,192	5.6	$14,714	$28,886
ROI Total or Average	**336,925**	**5.8**	**$15,308**	**$30,048**
Texas	**9,968,309**	**5.2**	**$16,617**	**$39,927**
U.S.	**n/a**	**4.8**	**$21,587**	**$50,046**

n/a = not available.
Source: FG Alliance, 2006c; USCB, 2000d and USCB, 2000e.

In 1999, the average median household income for the ROI was $30,048 and the average per capita income was $15,308 (FG Alliance, 2006c), while the median household income for the U.S. was $50,046 and the per capita income was $21,587 (USCB, 2000f and USCB, 2000g). In 1999, Texas had a median household income of $39,927 and an average per capita income of $16,617 (USCB, 2000f and USCB, 2000g). That same year, Freestone, Leon, and Limestone counties had an average median household income of $30,543 and an average per capita income of $16,096 (FG Alliance, 2006c). Based on 2000 Census data, Freestone, Leon, and Limestone counties and the ROI have median household and per capita incomes less than both the Texas and U.S. averages.

In 2004, Freestone, Leon, and Limestone counties collected $20.8 million in property taxes and in 2005 collected $20.8 million in sales taxes (FG Alliance, 2006c). The counties located within the ROI each collected an average of $8.8 million in sales taxes in 2005 (FG Alliance, 2006c).

Table 6.19-3 provides 2003 average hourly wages for Freestone, Leon, and Limestone counties for trades that would be required for construction of the proposed project. The maximum and minimum rates for these trades were not available. Although actual wage costs would not be known until contractor selection, it is expected that wages for construction of the proposed FutureGen Project would be typical for construction trades in these three counties adjusted for inflation.

Table 6.19-3. Average Hourly Wage Rates in 2003 by Trade in Freestone, Leon, and Limestone Counties in Texas

Trade	Average Wage Rate
Cement Mason	$8.38
Electrician	$10.62
Iron Worker	$9.13
Laborer	$5.24
Plumber/Pipefitter	$9.65

Source: GPO, 2003.

Housing

Table 6.19-4 provides total housing and vacant units by county within the ROI. As of 2000, there were a total of 237,924 existing housing units within the ROI, with Freestone, Leon, and Limestone counties accounting for 26,162 of those (FG Alliance, 2006c). Of the existing housing units within the ROI, 11 percent, or 26,163, were vacant (FG Alliance, 2006c). In 2005, Texas reported that 32.4 percent of vacant units were for rent and 10.9 percent were for sale (USCB, 2005b). There were approximately 8,477 units for rent and 2,852 units for sale within the ROI, and 1,775 units for rent and 597 units for sale within Freestone, Leon, and Limestone counties (FG Alliance, 2006c). In addition, there were at least 8,768 short-term hotel and motel rooms within the ROI (FG Alliance, 2006c).

There are no residences on or adjacent to the proposed power plant site and sequestration site.

Table 6.19-4. Total Housing Units Within the ROI for the Year 2000

County	Total Housing Units	Vacant Units
Freestone	8,138	1,550
Leon	8,299	2,110
Limestone	9,725	1,819
Anderson	18,436	2,758
Brazos	59,023	3,821
Falls	7,658	1,162
Houston	10,730	2,471
Madison	4,797	883
McLennan	84,795	5,936
Navarro	18,449	1,958
Robertson	7,874	1,695
Total	**237,924**	**26,163**

Source: FG Alliance, 2006c.

6.19.2.3 Workforce Availability

Construction

In 2004, there were approximately 336,925 people within the ROI workforce (FG Alliance, 2006c). Because construction workers represented 8.6 percent of the workforce in Texas, there were approximately 29,100 construction workers within the ROI (USCB, 2005c and FG Alliance, 2006c). This indicates that there could be a large local workforce from which some or all of the construction workers could be drawn.

Operations

Utility workers made up 1.0 percent of the workforce in Texas in 2004, resulting in approximately 3,500 workers within the ROI (USCB, 2005c). Operations workers could be drawn from this workforce.

6.19.3 IMPACTS

6.19.3.1 Construction Impacts

Population

The need for construction workers would be limited to the estimated 44-month construction period, and a potential influx of temporary residents is not expected to cause an appreciable increase in the regional population. Monthly employment on the proposed power plant site would average 350 workers during construction, with a peak of 700 workers (FG Alliance, 2006c). Approximately 30,600 general construction workers residing within the ROI would provide a local workforce. Temporary construction workers with specialized training and workers employed by contractors from outside the ROI could also be employed to construct the proposed power plant. Some of these workers would be expected to commute to the construction site on a daily or weekly basis, while others would relocate to the area for the duration of the construction period. Although it is not known how many workers would relocate, the required number of construction workers represents less than 0.1 percent of population within the ROI. Therefore, impacts on population growth within the ROI would be small.

Employment, Income, and Economy

Construction of the proposed facilities could result in 350 to 700 new jobs in Freestone, Leon, and Limestone counties. These new jobs would represent a 1.1 to 2.3 percent increase in the number of workers employed in these three counties (FG Alliance, 2006c). These workers would be paid consistent with wages in the area for similar trades. Wages for trades associated with power plant construction for 2003 are presented in Table 6.19-3, although it is likely that actual wages could be higher than those presented because of inflation. Therefore, a direct, but small, positive impact on employment rates and income could occur within the ROI during the construction period.

Texas and Freestone, Leon, and Limestone counties could benefit from temporarily increased sales tax revenue resulting from the project-related spending on payroll and construction materials. It is anticipated that construction workers would spend their wages on short-term housing, food, and other personal items within the ROI. Additional sales tax revenues would result from taxes embedded in the price of consumer items such as gasoline. Therefore, an indirect and positive impact could be expected for the local economy from increased spending and related sales tax revenue.

The properties potentially being acquired for the proposed FutureGen Project would receive tax abatements on property tax revenues for a period of 10 years. This would result in a loss of revenue to the taxing bodies associated with Anderson County. The total loss of revenue would be $5,884 per year based on current tax structures.

Housing

A potential influx of construction workers may increase local housing demand, which would have a beneficial short-term impact on the regional housing market. The ROI has approximately 8,477 vacant housing units for rent, with Freestone, Leon, and Limestone counties accounting for approximately 1,775 of these units. There are also at least 8,768 hotel rooms within the ROI, with Freestone, Leon, and Limestone counties accounting for approximately 750 of these rooms. In 2005, it is estimated that Texas had an average occupancy rate of 57.6 percent in 2005 (HO, 2005). Therefore, depending upon the percentage of construction jobs that could be filled by existing residents, the influx of workers from outside the region could increase the occupancy rate within the ROI by as much as 8 percent. This increase would result in a hotel occupancy rate of 65.6 percent and a positive, direct impact for the hotel industry within the ROI.

Power Plant Site

There are no existing residences or buildings on the proposed power plant site; therefore, no existing population would be displaced.

Sequestration Site

There are no existing residences or buildings on the proposed sequestration site; therefore, no existing population would be displaced.

6.19.3.2 Operational Impacts

Population

Operation of the proposed power plant could result in a very small increase in population growth. It is anticipated that power plant operation could require approximately 200 permanent workers. Based on the 2005 projected population and average family size within the ROI, the relocation of 200 workers could result in a population increase of 612 people. This would represent a 0.1 percent increase in population within the ROI and a 1.0 percent increase in population in Freestone, Limestone, and Leon counties.

Employment, Income, and Economy

The operational phase of the proposed FutureGen Project could have a direct and positive impact on employment by creating 200 permanent jobs in Freestone, Leon, and Limestone counties. These new jobs could represent a 0.06 percent increase in the total number of workers employed in these three counties (FG Alliance, 2006c).

Each new direct operations job created by the proposed FutureGen Project could generate both indirect and induced jobs. An indirect job supplies goods and services directly to the plant site. An induced job results from the spending of additional income from indirect and direct employees. A job multiplier is used to determine the approximate number of indirect and induced jobs that would result. An Economic Impact Analysis (EIA) was issued for Ford Park in Beaumont, Texas, in 2004 and reported a job multiplier of 1.6 (IDS, 2004). A job multiplier of 1.6 means that, for every direct job, 0.6 indirect or induced jobs could result. Based on this multiplier, the proposed FutureGen Project could have an indirect impact on employment by creating approximately 113 indirect or induced jobs in and around the ROI.

The proposed FutureGen Project would also have annual operation and maintenance needs that could benefit Freestone, Leon, and Limestone counties. Local contractors could be hired to complete specialized maintenance activities that could not be undertaken by permanent staff, and items such as repair materials, water, and chemicals could be purchased within the ROI. The 200 employees who would fill new jobs created by the proposed FutureGen Project could generate tax revenues from sales and use taxes on plant materials and maintenance. The property tax from the facility would be substantially greater than current property taxes paid for the properties to be acquired. Based on similar power plants, the increase in total property tax revenue could be in the millions of dollars each year. This increase would have a direct and positive impact on the total property tax revenue for Freestone, Leon, and Limestone counties and Texas. However, projected increases to property or sales tax revenues from the FutureGen Project may be less than anticipated if the state or local government were to waive or reduce usual assessments as an element of its final offer to the Alliance. Texas would likely benefit from a public utility tax it levies when power is produced by the proposed FutureGen Project.

Housing

During operation of the proposed power plant, employees relocating to the area would likely be distributed between owned and rental accommodations. Although it is not known how many of the permanent staff would relocate within the ROI, if all 200 permanent employees relocated, the increased demand for housing would be small. In Texas, approximately 64.7 percent of housing units are owner-occupied (USCB, 2005d). Using this value, operation of the proposed facilities could result in a 4.5 percent decrease in residences for sale and a 0.8 percent decrease in residences for rent within the ROI.

Power Plant Site

There are no existing residences or buildings on the proposed power plant site; therefore, no existing population would be displaced.

Sequestration Site

There are no existing residences or buildings on the proposed sequestration site; therefore, no existing population would be displaced.

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6.20 ENVIRONMENTAL JUSTICE

Specific populations identified under Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations" (59 *Federal Register* 7629), are examined here along with the potential of effects on these populations from construction and operation of the proposed FutureGen facility. In the context of this EIS, Environmental Justice refers specifically to the potential for minority and low-income populations to bear a disproportionate share of high and adverse environmental impacts from activities within the project area and the municipalities nearest to the proposed Jewett Power Plant Site, sequestration site and related corridors.

The U.S. Department of Energy defines "**Environmental Justice**" as: The fair treatment and meaningful involvement of all people—regardless of race, ethnicity, and income or education level—in environmental decision making. Environmental Justice programs promote the protection of human health and the environment, empowerment via public participation, and the dissemination of relevant information to inform and educate affected communities. DOE Environmental Justice programs are designed to build and sustain community capacity for meaningful participation for all stakeholders in DOE host communities (DOE, 2006).

6.20.1 INTRODUCTION

Executive Order 12898 directs federal agencies to achieve Environmental Justice as part of their missions by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of their actions on minority and low-income populations. Minorities are defined as individuals who are members of the following population groups: Native American or Alaska Native; Asian or Pacific Islander; Black, not of Hispanic origin; or Hispanic. To classify as a minority population, an area must have a population of these groups that exceeds 50 percent of the total population, or the minority population percentage of the affected area should be meaningfully greater than the minority population percentage in the general population or appropriate unit of geographical analysis (59 *Federal Register* 7629).

The Council on Environmental Quality (CEQ) guidance recommends that low-income populations in an affected area be identified using data on income and poverty from the U.S. Census Bureau (CEQ, 1997). Low-income populations are groups with an annual income below the poverty threshold, which was $19,971 for a family of four for calendar year 2006.

6.20.1.1 Region of Influence

The ROI includes the land area within 50 miles (80.5 kilometers) of the boundaries of the proposed power plant site, sequestration site, reservoir, and utility and transportation corridors. The proposed sequestration site is located approximately 33 miles (53.1 kilometers) north of the proposed plant site. The ROI includes the counties of Anderson, Brazos, Falls, Freestone, Houston, Leon, Limestone, Madison, McLennan, Navarro and Robertson. Section 6.19.1.1 describes the rationale for including these counties in the ROI.

6.20.1.2 Method of Analysis

DOE collected demographic information from the U.S. Census Bureau 2000 census to characterize low-income and minority populations within 50 miles (80.5 kilometers) of the proposed Jewett Power Plant Site and Sequestration Site. Census data are compiled at various levels corresponding to geographic areas and include, in order of decreasing size, states, counties, census tracts, block groups, and blocks. In order to accurately characterize and locate minority and low-income populations, DOE followed CEQ Guidance (CEQ, 1997) to determine minority and low-income characteristics using U.S., State of Texas, regional (defined by the 11-county ROI) and individual county data. The data presented in Table 6.20-1 show the overall composition and makeup of both minority and non-minority populations, and low-income populations within the ROI. Where available, DOE obtained U.S. Census data for local jurisdictions (i.e., towns and cities) to further identify the presence of minority or low-income populations. DOE used Census block group data (FG Alliance, 2006c) to examine the distribution of minority and low-income populations within the ROI.

DOE used potential environmental, socioeconomic, and health impacts identified in other sections of this EIS to assess potential impacts to Environmental Justice that could occur with the proposed construction and operation of the FutureGen Project.

DOE assessed the potential for impacts based on the following criteria:

- A significant and disproportionately high and adverse effect on a minority population; or
- A significant and disproportionately high and adverse effect on a low-income population.

Table 6.20-1. County, Regional and National Population and Low-income Distributions (2000)[1]

County	Total Population	White (percent)	Black (percent)	American Indian/ Alaska Native (percent)	Asian (percent)	Native Hawaiian/ Pacific Islander (percent)	Hispanic or Latino (all races) (percent)	Low-income (percent)
Counties Wholly Located Within the ROI								
Anderson	55,109	66.4	23.5	0.6	0.4	<0.1	12.2	16.5
Freestone	17,867	75.6	18.9	0.4	0.3	<0.1	8.2	14.2
Leon	15,335	83.5	10.4	0.3	0.2	<0.1	7.9	15.6
Limestone	22,051	70.8	19.1	0.5	0.1	<0.1	13.0	17.8
Madison	12,940	66.8	22.9	0.3	0.4	<0.1	15.8	15.8
Counties Partially Located Within the ROI								
Brazos	152,415	74.5	10.7	0.4	4.0	0.1	17.9	26.9
Falls	18,576	61.5	27.5	0.5	0.1	<0.1	15.8	22.6
Houston	23,185	68.6	27.9	0.3	0.2	0.1	7.5	21.0
McLennan	213,517	72.2	15.2	0.5	1.1	<0.1	17.9	17.6
Navarro	45,124	70.8	16.8	0.5	0.5	0.3	15.8	18.2
Robertson	16,000	66.2	24.2	0.4	0.2	0.1	14.7	20.6

Table 6.20-1. County, Regional and National Population and Low-income Distributions (2000)[1]

County	Total Population	White (percent)	Black (percent)	American Indian/ Alaska Native (percent)	Asian (percent)	Native Hawaiian/ Pacific Islander (percent)	Hispanic or Latino (all races) (percent)	Low-income (percent)
Regional and National Statistics								
11-County ROI	592,119	70.6	19.7	0.4	0.7	0.2	13.3	18.8
Texas	20,851,820	71.0	11.5	0.6	2.7	0.1	32.0	15.4
U.S.	281,421,906	75.1	12.3	0.9	3.6	0.1	12.5	12.4

[1] Some of the minority population counted themselves as more than one ethnic background, thus the counts do not add up to 100 percent.
Source: USCB, 2006.

6.20.2 AFFECTED ENVIRONMENT

6.20.2.1 Minority Populations

Table 6.20-1 compares the minority percentage and low-income percentage of county populations within the ROI with those of Texas and the nation. The 2000 Census revealed a more diverse population in Texas compared to the 1990 Census, especially regarding the Hispanic population. In 2000, 14.9 percent of Texas residents identified themselves as non-white (excluding Hispanic), down from 15.9 percent in 1990. During that same period, however, the percentage of population identifying themselves of Hispanic origin increased from 28.6 percent to 32 percent. With the exception of populations of Hispanic origin, the Texas population is less diverse than that of the nation.

Populations within the ROI have similar percentages (some counties slightly higher and some slightly lower) of people identifying themselves as white compared to overall Texas statistics, however, the ROI has a lower percentage of individuals of Hispanic origin when compared to the state. Populations within the ROI have non-minority populations (white) as the highest percentage (70.6 percent) compared to state (71.0 percent) and U.S. (75.1 percent) percentages. Although the populations within the ROI are greater than 50 percent non-minority, the counties within the ROI do have a higher percentage of minorities than state and national averages.

The proposed Jewett Power Plant Site would be located near the border of Limestone, Freestone and Leon counties, which have minority percentages of 27.8, 18.8 and 32.7 percent, respectively. Similar percentages would be expected for associated utility and transportation corridors.

The largest minority populations in the region are to the south and to the north of the proposed Jewett Sequestration Site and reservoir. This area includes state land managed by the Texas Department of Criminal Justice (Coffield State Prison, approximately 4,115 inmates), located within the western edge of Anderson County. The overall population of Anderson County identifies itself as 66.4 percent white, or non-minority, 24.5 percent as minority, and 12.2 percent as Hispanic or Latino origin of any race. The proposed sequestration site is also located within Freestone County which has a minority population of 19.6 percent with an additional 8.2 percent of the population identifying themselves as Hispanic or Latino of any race.

Due to the high percentage of individuals of minority origin near the proposed Jewett Sequestration Site, a "minority population" as characterized by CEQ does exist in the potentially affected area. No large percentages of minority populations are located near the proposed plant site or corridors.

6.20.2.2 Low-Income Populations

Most of the by-county percentages of low-income populations for individuals exceed the state percentage (15.4 percent) and all of them exceed the national percentage (12.4 percent) (Table 6.20-1). However, the majority (81.8 percent) of the ROI is at or above the poverty level (annual household income above $19,971).

6.20.3 IMPACTS

This section discusses the potential for disproportionately high and adverse impacts on minority and low-income populations associated with the proposed FutureGen Project. The CEQ's December 1997 Environmental Justice Guidance (CEQ, 1997) provides guidelines regarding whether human health effects on minority populations are disproportionately high and adverse. CEQ advised agencies to consider the following three factors to the extent practicable:

- Whether the health effects, which may be measured in risks and rates, are significant (as defined by NEPA), or above generally accepted norms. Adverse health effects may include bodily impairment, infirmity, illness, or death.
- Whether the risk or rate of hazard exposure by a minority population, low-income population, or Native American tribe to an environmental hazard is significant (as defined by NEPA) and appreciably exceeds or is likely to appreciably exceed the risk or rate to the general population or other appropriate comparison group.
- Whether health effects occur in a minority population, low-income population, or Native American tribe affected by cumulative or multiple adverse exposures from environmental hazards.

Based on the definitions in Section 6.20.1, the criteria outlined above, and the findings regarding environmental and socioeconomic impacts throughout this EIS, the analysis for Environmental Justice in this EIS were performed in the following sequence:

Using data from the 2000 Census, the potential for adverse environmental or socioeconomic impacts resulting from site-specific or corridor-specific project activities (construction or operation) to affect a minority population in the ROI and have a disproportionately high and adverse effect, as defined by CEQ and described in Section 6.20.1, was determined.

Using data from the 2000 Census, the potential for adverse environmental or socioeconomic impacts resulting from site-specific or corridor-specific project activities (construction or operation) to affect a low-income population in the ROI and have a disproportionately high and adverse effect, as defined by CEQ and described in Section 6.20.1, was determined.

Using the impacts analyzed in Section 6.17, the potential for adverse health risks in a wider radius from project sites and corridors was compared with the potential adverse health risks that could affect a minority population or low-income population at a disproportionately high and adverse rate.

Using the impacts analyzed in Section 6.17, the potential for health effects in a minority population or low-income population affected by cumulative or multiple adverse exposures to environmental hazards was determined.

6.20.3.1 Construction Impacts

As discussed in Section 6.20.2.1, areas of minority populations, as defined by EO 12898, are located near the sequestration site. The sequestration site is located along the border of Freestone and Anderson counties. Anderson County (which includes the population at Coffield State Prison) has 33.6 percent of individuals identifying themselves as minority. This percentage is higher than regional (29.4 percent), state (29.0 percent) and national (24.9 percent) percentages, however, it is below the 50 percent threshold as defined in EO 12898. Due to some of the minority population counting themselves as belonging to more than one ethnic background, DOE calculated the percentages by subtracting the White population Census numbers from 100 percent (e.g., 100 percent – 66.4 percent = 33.6 percent for Anderson County). No disproportionately high and adverse impacts are anticipated to minority populations. Construction activities may cause temporary air quality, water quality, transportation and noise impacts to the general population (see Sections 6.2, 6.7, 6.13, and 6.14).

The proposed power plant would be located at the intersection of Limestone, Leon and Freestone counties, which predominantly have a higher percentage of low-income populations (at 17.8, 15.6, and 14.2 percent, respectively) in comparison to the state (15.4 percent) and national (12.4 percent) percentages. The proposed sequestration sites would be located in Freestone County, discussed above, and Anderson County which has a 16.5 percent low-income population. All of these percentages, however, are far below the 50 percent threshold as defined in EO 12898. No disproportionately high and adverse impacts are anticipated to low-income populations. Construction activities may cause temporary air quality, water quality, transportation, and noise impacts to the general population (see Sections 6.2, 6.7, 6.13, and 6.14). Short-term beneficial impacts may include an increase in employment opportunities and potentially higher wages, or supplemental income through jobs created during facility construction.

6.20.3.2 Operational Impacts

Aesthetics and noise impacts (see Sections 6.12 and 6.14) resulting from operations were determined not to have a disproportionately high and adverse effect to minority or low-income populations.

One of the proposed sequestration sites would potentially be located within the Coffield State Prison complex. The potential risks to health were determined to be from the unlikely event of a pipeline rupture or puncture, the extremely unlikely event of a wellhead equipment rupture, and a catastrophic accident, terrorism, or sabotage, which cannot be predicted (Section 6.17). The injection well would be located away from the prison facility. This potential for pipeline rupture or puncture would be uniform across the general population along the CO_2 utility corridors. Therefore, no disproportionately high and adverse impacts are anticipated.

Long-term beneficial impacts would be anticipated due to an increase in employment opportunities and potentially higher wage jobs associated with facility operation.

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6.21 REFERENCES

6.1 Chapter Overview

Energy Information Administration (EIA). 2000. *Energy Policy Act Transportation Rate Study: Final Report on Coal Transportation.* Accessed January 1, 2007 at ftp://ftp.eia.doe.gov/pub/pdf/coal.nuclear/059700.pdf

FutureGen Alliance (FG Alliance). 2006c. "Heart of Brazos Site Environmental Information Volume."

6.2 Air Quality

40 CFR Part 6. "Procedures for Implementing the Requirements of the Council on Environmental Quality on the National Environmental Policy Act." U.S. Environmental Protection Agency, *Code of Federal Regulations*.

40 CFR 51.166. "Requirements for Preparation, Adoption and Submittal of Implementation Plans: Prevention of Significant Deterioration of Air Quality." U.S. Environmental Protection Agency, *Code of Federal Regulations*.

40 CFR 52.21. "Prevention of Significant Deterioration of Air Quality." U.S. Environmental Protection Agency, *Code of Federal Regulations*.

40 CFR Part 93. "Determining Conformity of Federal Actions to State or Federal Implementation Plans." U.S. Environmental Protection Agency, *Code of Federal Regulations*.

FutureGen Alliance (FG Alliance). 2006c. "Heart of Brazos Site Environmental Information Volume."

FG Alliance. 2006e. "FutureGen Project Description, Data Needs Table, Operational Parameters and Assumptions and Unplanned Starts."

FG Alliance. 2007. "Initial Conceptual Design Report."

South Coast Air Quality Management District (SCAQMD). 2003. *Guidelines for Fugitive Emissions Calculations*. Accessed January 3, 2007 at www.ecotek.com/aqmd/2006/forms_and_instructions_pdf/2003_fugitive_guidelines.pdf

Taylor, G. W.R. 2001. *Trucks and Air Emissions, Final Report*. Prepared for Transportation Systems Branch, Air Pollution Prevention, Environmental Protection Service, Environment Canada. March 2001. Accessed April 9, 2007 at http://www.ec.gc.ca/cleanair-airpur/CAOL/transport/publications/trucks/trucktoc.htm (last updated December 11 2002).

Texas Commission on Environmental Quality (TCEQ). 2006. *Mercury in Texas: Background, Federal Rules, Control Technologies, and Fiscal Implications; Implementation of Section 2, HB 2481 (79th Legislature)—A Report to the Texas Legislature*. Accessed April 3, 2007 at http://www.tceq.state.tx.us/assets/public/comm_exec/pubs/sfr/085.pdf

U.S. Department of Energy (DOE). 2006a. “Emissions of Greenhouse Gases in the United States 2005.” Washington, DC.

DOE. 2006b. *The Turbines of Tomorrow*. Accessed January 5, 2007 at http://www.fe.doe.gov/programs/powersystems/turbines/index.html (last updated November 9, 2006).

DOE. 2007. *Final Environmental Impact Statement for the Orlando Gasification Project, January 2007*. Accessed March 8, 2007 at http://www.eh.doe.gov/NEPA/eis/eis0383/index.html

U.S. Environmental Protection Agency (EPA). 1980. “A Screening Procedure for the Impacts of Air Pollution Sources on Plants, Soils, and Animals.” Washington, DC.

EPA. 1990. “New Source Review Workshop Manual, Prevention of Significant Deterioration and Nonattainment Area Permitting.” Draft, October 1990. Washington, DC.

EPA. 2005. “Regional Haze Regulations and Guidelines for Best Available Retrofit Technology (BART) Determinations.” Washington, DC.

EPA. 2006a. *Air Data. Monitor Values Report – Criteria Air Pollutants*. Accessed December 28, 2006 at http://www.epa.gov/air/data/monvals.html (last updated September 26, 2006).

EPA. 2006b. *eGRID – Emissions and Generation Resource Integrated Database (eGRID)*. Accessed December 1, 2006 at http://www.epa.gov/cleanenergy/egrid/index.htm (last updated October 30, 2006).

EPA. 2006c. *National Ambient Air Quality Standards (NAAQS)*. Accessed November 8, 2006 at http://www.epa.gov/air/criteria.html (last updated October 13, 2006).

EPA. 2007. *Acid Rain Program*. Accessed April 27, 2007 at http://www.epa.gov/airmarkets/progsregs/arp/index.html (last updated February 2, 2007).

U.S. Fish and Wildlife Service (FWS). 2007. *Permit Application, PSD Overview*. Accessed January 27, 2007 at http://www.fws.gov/refuges/AirQuality/permits.html (last updated August 14, 2006).

6.3 Climate and Meteorology

Blue Planet Biomes. 2006. *World Climates*. Accessed December 1, 2006 at http://www.blueplanetbiomes.org/climate.htm (last updated November 7, 2006).

FutureGen Alliance (FG Alliance). 2006c. “Heart of Brazos Site Environmental Information Volume.”

National Oceanic and Atmospheric Administration (NOAA). 2006. *Storm Events*. Accessed December 2, 2006 at http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms (updated daily).

The Tornado Project. 1999. *The Fujita Scale*. Accessed December 1, 2006 at http://www.tornadoproject.com/fscale/fscale.htm

6.4 Geology

FutureGen Alliance (FG Alliance). 2006c. "Heart of Brazos Site Environmental Information Volume."

Illinois State Geological Survey (ISGS). 1995. *Damaging Earthquakes in Illinois*. Accessed ***July 18, 2007 at http://crystal.isgs.uiuc.edu/ research/earthquake-hazards/pdf-files/qk-fct-damag.pdf***.

Intergovernmental Panel on Climate Change (IPCC). 2005. *Special Report on Carbon Dioxide Capture and Storage*. Accessed December 10, 2006 at http://www.ipcc.ch/activity/srccs/index.htm (last updated January 16, 2006).

Louie, J. 1996. *What is Richter Magnitude?* Accessed October 5, 2006 at http://www.seismo.unr.edu/ftp/pub/louie/class/100/magnitude.html (last updated October 9, 1996).

U.S. Geological Survey (USGS). 2006. ***Earthquake Hazards Program: Earthquake Search, Circular Area***. Accessed October 6, 2006 at ***http://neic.usgs.gov/neis/epic/epic_circ.html***

University of Texas at Austin (UTA). 2006. "Response to FutureGen Alliance Geohydrologic Conceptual Model Data Request Package." Austin, TX.

6.5 Physiography and Soils

Damen, K., A. Faaij and W. Turkenburg. 2003. "Health, Safety and Environmental Risks of Underground CO_2 Sequestration." Copernicus Institute for Sustainable Development and Innovation, Department of Science, Technology and Society, Utrecht, The Netherlands.

FutureGen Alliance (FG Alliance). 2006c. "Heart of Brazos Site Environmental Information Volume."

Horizon Environmental Services, Inc. 2006. "Phase I Environmental Site Assessment, Heart of Brazos FutureGen Site, Leon, Limestone, and Freestone Counties, Texas." Austin, TX. ***In FG Alliance, 2006c, Attachment 3.***

University of Texas at Austin (UTA). 2006. *Physiography of Texas*. Accessed October 9, 2006 at http://www.lib.utexas.edu/geo/physiography.html (last updated July 24, 2006).

6.6 Groundwater

30 TAC 331. "Underground Injection Control." *Texas Administrative Code*.

FutureGen Alliance (FG Alliance). 2006c. "Heart of Brazos Site Environmental Information Volume."

Intergovernmental Panel on Climate Change (IPCC). 2005. *Special Report on Carbon Dioxide Capture and Storage*. Accessed December 10, 2006 at http://www.ipcc.ch/activity/srccs/index.htm (last updated January 16, 2006).

Texas Commission on Environmental Quality (TCEQ). 2006. *Joint Groundwater Monitoring and Contamination Report, 2005*. *SFR 056/05*. Accessed December 17, 2006 at http://www.tceq.state.tx.us/comm_exec/forms_pubs/pubs/sfr/056_05_index.html (last updated July 20, 2006).

Texas Water Development Board (TWDB). 1972. "Report 150: Ground-Water Conditions in Anderson, Cherokee, Freestone, and Henderson Counties, Texas." Austin, TX.

TWDB. 1997. *1997 State Water Plan*. Accessed January 23, 2007 at http://rio.twdb.state.tx.us/publications/reports/State_Water_Plan/1997/Ch_3.2_Regions.pdf

TWDB. 2003. "Groundwater Availability Model for the Central Part of the Carrizo-Wilcox Aquifer in Texas." Austin, TX.

TWDB. 2006a. *Well Location Data and GIS Data Layers*. Accessed September 1, 2006 and October 5, 2006 at http://www.twdb.state.tx.us/mapping/gisdata.asp

TWDB. 2006b. "GAM Run 06-05." Austin, TX.

TWDB. 2006c. *2007 State Water Plan**: **Summary of Brazos G Region***. Accessed ***September 6***, 2007 at ***http://www.twdb.state.tx.us/publications/reports/State_Water_Plan/2007/2007StateWaterPlan/Chapter02_regG.pdf***

U.S. Environmental Protection Agency (EPA). 2006a. *Designated Sole Source Aquifers in EPA Region VI*. Accessed December 15, 2006 at http://www.epa.gov/safewater/sourcewater/pubs/qrg_ssamap_reg6.pdf

EPA. 2006b. *Underground Source of Drinking Water*. Accessed March 11, 2007 at http://www.epa.gov/safewater/uic/usdw.html (last updated February 28, 2006).

EPA 2007. *Using the Class V Experimental Technology Well Classification for Pilot Geologic Sequestration Projects. UIC Program Guidance (UICP #83), Underground Injection Control Program, Geologic Sequestration of Carbon Dioxide*. Accessed March 20, 2007 at http://www.epa.gov/safewater/uic/index.html (last updated March 2, 2007).

University of Texas at Austin (UTA). 1985. "The Wilcox Group and Carrizo Sand (Paleogene) in East-Central Texas: Depositional Systems and Deep-Basin Lignite." Austin, TX.

6.7 Surface Water

Benson, S., R. Hepple, J. Apps, C. Tsang and M. Lippman. 2002. "Lessons Learned from Natural and Industrial Analogues for Storage of Carbon Dioxide in Deep Gas Formations." Earth Sciences Division, E.O. Lawrence Berkeley National Laboratory, Berkeley, CA.

Damen, K., A. Faaij and W. Turkenburg. 2003. "Health, Safety and Environmental Risks of Underground CO_2 Sequestration." Copernicus Institute for Sustainable Development and Innovation, Department of Science, Technology and Society, Utrecht, The Netherlands.

FutureGen Alliance (FG Alliance). 2006c. "Heart of Brazos Site Environmental Information Volume."

Reichle, D., J. Houghton, B. Kane and J. Ekmann. 1999. "Carbon Sequestration Research and Development." U.S. Department of Energy, Office of Science, Office of Fossil Energy, Oak Ridge, TN.

TetraTech. 2007. "Final Risk Assessment Report for the FutureGen Project Environmental Impact Statement." April 2007 (Revised). Lafayette, CA.

Texas Commission on Environmental Quality (TCEQ). 2004. *Brazos River Basin: 2004 Assessment (Segment 1252 – Lake Limestone)*. Accessed November 28, 2006 at http://www.tceq.state.tx.us/compliance/monitoring/water/quality/data/04twqi/basins/brazos.html (last updated May 25, 2006).

TCEQ. 2006a. *Trinity River Basin (08) and Portion of Bays and Estuaries (24)*. Accessed November 28, 2006 at ***http://www.tceq.state.tx.us/files/basin08-Trinity-PBE.pdf_4024818.pdf*** (last updated May 8, 2006).

TCEQ. 2006b. *Class III Injection Wells Regulated By The TCEQ: Technical Guideline III: Fluid Handling*. Accessed January 24, 2007 at http://www.tceq.state.tx.us/permitting/waste_permits/uic_permits/UIC_Guidance_Class_3.html (last updated June 13, 2006).

Texas Natural Resource Conservation Commission (TNRCC). 2000. *Chapter 307, Texas Surface Water Quality Standards. Trinity River Basin, Segment 0804, Trinity River above Lake Livingston*. Accessed January 15, 2007 at http://www.tceq.state.tx.us/permitting/water_quality/wq_assessment/standards/WQ_standards_2000.html

Trinity River Authority (TRA). 2006. *Map of the Trinity River Watershed (Water Quality Data Viewer)*. Accessed December 5, 2006 at http://www.trinityra.org/BasinPlan/CRP/viewer/ViewMap.asp

USDA. 1998. "Soil Survey of Limestone County, Texas." Washington, DC.

USDA. 2002. "Soil Survey of Freestone County, Texas." Washington, DC.

6.8 Wetlands and Floodplains

10 CFR Part 1022. "Compliance with Floodplain and Wetland Environmental Review Requirements." U.S. Department of Energy, *Code of Federal Regulations*.

42 *Federal Register* 26951. "Executive Order 11988 – Floodplain Management." Federal Register. May 24, 1977.

42 *Federal Register* 26961. "Executive Order 11990 – Protection of Wetlands." Federal Register. May 24, 1977.

Cowardin, L. M., V. Carter, F. C. Golet and E. T. LaRoe. 1979. "Classification of Wetlands and Deepwater Habitats of the United States." U.S. Fish and Wildlife Service FWS/OBS-79/31.

FutureGen Alliance (FG Alliance). 2006c. "Heart of Brazos Site Environmental Information Volume."

Kantor, T. L. 2006. Letter from T. L. Kantor, Engineer and Floodplain Administrator, Limestone County Road and Bridge Department, Groesbeck, TX to Scott W. Tinker, Director, Bureau of Economic Geology, The University of Texas at Austin, Austin, TX. ***In FG Alliance, 2006c, Attachment 8.***

Natural Resources Conservation Service (NRCS). 2006. *Soil Data Mart*. Accessed October 19, 2006 at http://soildatamart.nrcs.usda.gov (last updated July 15, 2006).

6.9 Biological Resources

FutureGen Alliance (FG Alliance). 2006c. "Heart of Brazos Site Environmental Information Volume."

DOE. 2007. *Final Environmental Impact Statement for the Orlando Gasification Project, January 2007*. Accessed March 8, 2007 at http://www.eh.doe.gov/NEPA/eis/eis0383/index.html

Intergovernmental Panel on Climate Change (IPCC). 2005. *Special Report on Carbon Dioxide Capture and Storage*. Accessed December 10, 2006 at http://www.ipcc.ch/activity/srccs/index.htm (last updated January 16, 2006).

6.10 Cultural Resources

16 USC 470. "The National Historic Preservation Act of 1966, as amended through 2000. U.S." Federal Government, *U.S. Code*.

36 CFR Part 60. "National Register of Historic Places." U.S. Department of the Interior, National Park Service, *Code of Federal Regulations*.

36 CFR Part 62. "National Natural Landmarks Program." U.S. Department of the Interior, National Park Service, *Code of Federal Regulations*.

36 CFR Part 800. "Protection of Historic Properties." U.S. Department of the Interior, Advisory Council on Historic Preservation, *Code of Federal Regulations*.

FutureGen Alliance (FG Alliance). 2006c. "Heart of Brazos Site Environmental Information Volume."

FutureGen Site Proposal (Jewett, Texas). 2006. "Proposal for FutureGen Host Site." Submitted in Response to the March 7, 2006 Request for Proposals for FutureGen Facility Host Site.

King, T. F. 1998. "Cultural Resource Laws and Practice." AltaMira Press, Walnut Creek, CA.

Miller, M. and S. W. Yost. 2006. "Cultural Resource Overview of Proposed FutureGen Heart of Brazos, Leon, Limestone, and Freestone Counties, Texas." El Paso, TX. ***In FutureGen Site Proposal (Jewett, Texas), 2006.***

National Park Service (NPS). 2004. *National Natural Landmarks, NNL Guide*. Accessed December 2, 2006 at http://www.nature.nps.gov/nnl/Registry/USA_Map/index.cfm (last updated February 5, 2004).

NPS. 2006a. *National Register Information System*. Accessed December 3, 2006 at http://www.cr.nps.gov/nr/research/nris.htm (last updated August 18, 2006).

NPS. 2006b. *Native American Consultation Database*. Accessed December 6, 2006 at http://home.nps.gov/nacd/ (last updated March 31, 2006).

Texas Historical Commission (THC). 2006. *Texas Archaeological Sites Atlas*. Accessed December 2, 2006 at http://nueces.thc.state.tx.us/

University of Texas at Austin (**UTA**). 1996. "Physiographic Map of Texas." Austin, TX.

6.11 Land Use

14 CFR Part 77. "Objects Affecting Navigable Airspace." Federal Aviation Administration, *Code of Federal Regulations*.

De Figueiredo, M. A., D. M. Reiner and H. J. Herzog. 2005. "Framing the Long-Term In Situ Liability Issue for Geologic Carbon Storage in the United States." *Mitigation and Adaptation Strategies for Global Change* 10 (4): 647-657.

FutureGen Alliance (FG Alliance). 2006c. "Heart of Brazos Site Environmental Information Volume."

Horizon Environmental Services, Inc. 2006. "Phase I Environmental Site Assessment, Heart of Brazos FutureGen Site, Leon, Limestone, and Freestone Counties, Texas." Austin, TX. ***In FG Alliance, 2006c, Attachment 3.***

Karriker, J. 2006. Personal communication. Discussions and On-Site Meeting between Peter Sparhawk, The Louis Berger Group, Inc., and Jerry Karriker, Farm Programs Specialist II, Coffield and Beto Units Agriculture, Texas Department of Criminal Justice, Agribusiness, Land & Minerals, Tennessee Colony, Texas. November 28, 2006.

National Resources Conservation Service (NRCS). 2000. *National Resource Inventory. Illinois Highlights. 1997 National Resources Inventory*. Accessed October 16, 2006 at http://www.il.nrcs.usda.gov/technical/nri/highlights.html (last updated December 2000).

NRCS. 2006. *Soil Data Mart*. Accessed August 24, 2006 at http://soildatamart.nrcs.usda.gov (last updated July 15, 2006).

Texas Parks and Wildlife Department (TPWD). 2006. *State Parks and Destinations*. Accessed August 24, 2006 at http://www.tpwd.state.tx.us/spdest/

Trouart, J. 2006. Personal communication. Discussions and On-Site meeting between Peter Sparhawk, The Louis Berger Group, Inc., and Joel Trouart, Vice President, State Government Relations, Westmoreland Mining LLC, Jewett, Texas. November 27, 2006.

6.12 Aesthetics

FutureGen Alliance (FG Alliance). 2006c. "Heart of Brazos Site Environmental Information Volume."

King, T. F. 1998. “Cultural Resource Laws and Practice.” AltaMira Press, Walnut Creek, CA.

Texas Legislation Online (TLO). 2006. *Texas Statutes*. Accessed August 24, 2006, at http://www.capitol.state.tx.us/ (last updated May 16, 2006).

Texas Parks and Wildlife Department (TPWD). 2006. *State Parks and Destinations*. Accessed August 24, 2006 at http://www.tpwd.state.tx.us/spdest/

U.S. Department of Energy (DOE). 2006a. “Draft Environmental Impact Statement for the Orlando Gasification Project.” Orlando, FL.

DOE. 2006b. *FutureGen – Tomorrow's Pollution-Free Power Plant*. Accessed December 28, 2006 at http://www.fossil.energy.gov/programs/powersystems/futuregen/ (last updated December 14, 2006).

Wilkinson, T. 2006. Telephone conversation of Tom Wilkinson, Executive Director, Brazos Valley Council of Governments, with M. Archambeault. August 24, 2006.

6.13 Transportation and Traffic

American Association of State Highway and Transportation Officials (AASHTO). 2004. “A Policy on Geometric Design of Highways and Streets.” Washington, DC.

FutureGen Alliance (FG Alliance). 2006c. “Heart of Brazos Site Environmental Information Volume.”

FG Alliance. 2006e. “FutureGen Project Description, Data Needs Table, Operational Parameters and Assumptions and Unplanned Starts.”

Texas Department of Transportation (TxDOT). 2005. *Texas Rail System Plan*. Accessed December 11, 2006 at http://www.txdot.gov/services/transportation_planning_and_programming/rail_plan.htm

TxDOT. 2006a. *TxDOT Transportation Studies*. Accessed November 17, 2006 at http://www.dot.state.tx.us/mis/mis.htm

TxDOT. 2006b. *Texas Highway Designation Files*. Accessed November 17, 2006 at http://www.dot.state.tx.us/tpp/search/query.htm

TxDOT. 2006c. *Roadway Design Manual*. Accessed May 1, 2007 at ftp://ftp.dot.state.tx.us/pub/txdot-info/gsd/manuals/rdw.pdf

Transportation Research Board (TRB). 2000. “Highway Capacity Manual.” Washington, DC.

Walden, S., 2006. Personal communication. Email from Steve Walden, Steve Walden Consulting, Austin, TX, to Lucy Swartz, Battelle Memorial Institute, Aberdeen, MD. December 14, 2006.

6.14 Noise

Bolt, Beranek, and Newman 1971. "Noise from Construction Equipment and Operations, Building Equipment, and Home Appliances." Prepared for the U.S. Environmental Protection Agency, Washington, DC.

Bolt, Beranek, and Newman. 1984. "Electric Power Plant Environmental Noise Guide. Volume 1, 2nd edition." Prepared for Edison Electric Institute.

Cowan, J. P. 1994. "Handbook of Environmental Acoustics." John Wiley & Sons, Inc.

Federal Highway Administration (FHWA). 1992. *Highway Traffic Noise*. Accessed December 27, 2006 at http://www.fhwa.dot.gov/environment/htnoise.htm (last updated December 14, 2006).

Federal Transit Administration (FTA). 2006. "Transit Noise and Vibration Impact Assessment." Harris Miller Miller and Hanson, Inc. Washington, DC.

FutureGen Alliance (FG Alliance). 2006c. "Heart of Brazos Site Environmental Information Volume."

Metropolitan Transportation Authority / City of New York Planning Commission (MTA). 2004. Final Generic Environmental Impact Statement, No. 7 Subway Extension, Hudson Yards Rezoning & Development Program, CEQR No. 03DCP031M. November 2004.

New York State Department of Environmental Conservation (NYSDEC). 2000. "Assessing and Mitigating Noise Impacts." Albany, NY.

U.S. Department of Energy (DOE). 2006. "Draft Environmental Impact Statement for the Orlando Gasification Project." Orlando, FL.

VIBCO. Undated-a. "High Frequency Silent Models." Wyoming, RI.

VIBCO. Undated-b. "Silent Pneumatic CC Series." Wyoming, RI.

Western Safety Products. 2007. *Aldon Rail Safety Page 6*. Accessed April 3, 2007 at http://www.westernsafety.com/aldon/aldonpage6.html (last updated March 28, 2007).

6.15 Utility Systems

Electric Reliability Council of Texas (ERCOT). 2006a. "*2005 Annual Report*." Austin, TX.

ERCOT. 2006b. "Future Generation Interconnection Security Screening Study, Leon and Ector County Locations." Austin, TX.

Energy Information Administration (EIA). 2006. "Annual Energy Outlook 2006 with Projections to 2030." Washington, DC.

FutureGen Alliance (FG Alliance). 2006c. "Heart of Brazos Site Environmental Information Volume."

FG Alliance. 2006e. “FutureGen Project Description, Data Needs Table, Operational Parameters and Assumptions and Unplanned Starts.”

North American Electric Reliability Council (NERC). 2006. “2006 Long-Term Reliability Assessment: The Reliability of the Bulk Power Systems in North America.” Princeton, NJ.

6.16 Materials and Waste Management

30 TAC 330.3. “Definitions.” *Texas Administrative Code*.

30 TAC 330.5. “Classification of Municipal Solid Waste Facilities.” *Texas Administrative Code*.

30 TAC 330.173 “Operational Standards for Municipal Solid Waste Landfill Facilities.” *Texas Administrative Code*.

30 TAC 335.5 “Deed Recordation of Waste Disposal.” *Texas Administrative Code*.

30 TAC 335.6 “Notification Requirements.” *Texas Administrative Code*.

American Coal Ash Association (ACAA). 2006. *2005 Coal Combustion Product (CCP) Production and Use Survey*. Accessed November 4, 2006 at http://www.acaa-usa.org/PDF/2005_CCP_Production_and_Use_Figures_Released_by_ACAA.pdf

Best, S. 2006. *New Grimes County Landfill*. Telecon Record, S. Best, Brazos Valley Development Council Landfill Supervisor, and M. Hoganson, TtNUS. December 11,2006.

California Integrated Waste Management Board (CIWMB). 2006. *Estimated Solid Waste Generation Rates for Industrial Establishments*. Accessed November 9, 2006 at http://www.ciwmb.ca.gov/WasteChar/WasteGenRates/Industrial.htm (last updated December 7, 2004).

Ciba. 2006. *Water Treatment*. Accessed November 6, 2006 at http://www.cibasc.com/index/ind-index/ind-water_treatment.htm

Energy Information Administration (EIA). 2006. *U.S. Coal Consumption by End Use Sector, by Census Division and State*. Accessed December 7, 2006 at http://www.eia.doe.gov/cneaf/coal/page/acr/table26.html

FutureGen Alliance (FG Alliance). 2006c. “Heart of Brazos Site Environmental Information Volume.”

FG Alliance. 2006e. “FutureGen Project Description, Data Needs Table, Operational Parameters and Assumptions and Unplanned Starts.”

FG Alliance. 2007. “Initial Conceptual Design Report.”

FutureGen Site Proposal (Jewett, Texas). 2006. “Proposal for FutureGen Host Site.” Submitted in Response to the March 7, 2006 Request for Proposals for FutureGen Facility Host Site.

Horizon Environmental Services, Inc. 2006. “Phase I Environmental Site Assessment, Heart of Brazos FutureGen Site, Leon, Limestone, and Freestone Counties, Texas.” Austin, TX. ***In FG Alliance, 2006c, Attachment 3.***

Morris, R. J. 2003. *Sulphur Surplus in the Making Impacts Refineries*. Accessed October 30, 2006 at http://www.sulphurinstitute.org/Morris.NPRApaper.pdf

Railroad Commission of Texas (RRC). 2004. *Coal Mining Locations*. Accessed December 15, 2006 at http://www.rrc.state.tx.us/divisions/sm/sm_info/forms/TXCoalOp.pdf.

Texas Commission on Environmental Quality (TCEQ). 2006a. Letter from Dan Eden, Deputy Director, TCEQ, Austin, TX, to Scott W. Tinker, Director, Bureau of Economic Geology, The University of Texas at Austin, Austin, TX. April 27, 2006.

TCEQ. 2006b. *Municipal Solid Waste in Texas: A Year in Review. FY 2005 Data Summary and Analysis*. Accessed November 27, 2006 at http://www.tceq.state.tx.us/assets/public/comm_exec/pubs/as/187_06.pdf (last updated October 16, 2006).

TCEQ. 2006c. *Storm Water Permits*. Accessed October 15, 2006 at http://www.tceq.state.tx.us/nav/permits/sw_permits.html

The Innovation Group (TIG). 2002. *Chemical Profiles: Sulfur*. Accessed November 6, 2006 at http://www.the-innovation-group.com/ChemProfiles/Sulfur.htm

TIG. 2003. *Chemical Profiles: Sodium Hypochlorite*. Accessed November 6, 2006 at http://www.the-innovation-group.com/ChemProfiles/Sodium%20Hypochlorite.htm

U.S. Environmental Protection Agency (EPA). 2003. *Wastes. 2003 National Biennial Report*. Accessed December 4, 2006 at http://www.epa.gov/epaoswer/hazwaste/data/br03/index.htm (last updated February 23, 2006).

U.S. Geological Survey (USGS). 2006a. *Mineral Commodity Summaries– Lime*. Accessed December 4, 2006 http://minerals.er.usgs.gov/minerals/pubs/commodity/lime/lime_mcs06.pdf

USGS. 2006b. *Mineral Industry Surveys – Directory of Lime Plants in the United States in 2005*. Accessed December 4, 2006 http://minerals.er.usgs.gov/minerals/pubs/commodity/lime/limedir05.pdf

6.17 Human Health, Safety and Accidents

American Industrial Hygiene Association (AIHA), 1997. "Odor Thresholds for Chemicals with Established Occupational Health Standards." Fairfax, VA.

Department of Health and Human Services (DHHS). 2006. "The State of Childhood Asthma, United States, 1980–2005." National Center for Health Statistics. Advance Data from Vital and Health Statistics. Number 381. Revised December 29, 2006.

Ermak, D. L. 1990. "User's Manual for SLAB: An Atmospheric Dispersion Model for Denser-Than-Air Releases." Report UCRL-MA-105607, University of California, Lawrence Livermore National laboratory, Livermore, CA.

FutureGen Alliance (FG Alliance). 2006a. "Mattoon Dole Site Environmental Information Volume."

FG Alliance. 2006b. "Tuscola Site Environmental Information Volume."

FG Alliance. 2006c. "Heart of Brazos Site Environmental Information Volume."

FG Alliance. 2006d. "Odessa Site Environmental Information Volume."

FG Alliance. 2006e. "FutureGen Project EIS Project Description Data Needs Table Operational Parameters and Assumptions Unplanned Starts."

Gale, J. and J. Davison. 2004. "Transmission of CO_2 – Safety and Economic Considerations." *Energy* 29 (9-10): 1319-1328.

Gilmour, M I., M. S. Jaakkola, S. J. London, A. E. Nel and C. A. Rogers. 2006. "How Exposure to Environmental Tobacco Smoke, Outdoor Air Pollutants, and Increased Pollen Burdens Influences the Incidence of Asthma." *Environmental Health Perspectives* 114: 627-633.

Hanna, S. R. and P. J. Drivas. 1987. "Guidelines for Use of Vapor Cloud Dispersion Models." Center for Chemical Process Safety, American Institute of Chemical Engineers. NY.

Interstate Oil and Gas Compact Commission (IOGCC). 2005. "Carbon Capture and Storage: A Regulatory Framework for States - Summary of Recommendations." Oklahoma City, OK. January 24, 2005.

Intergovernmental Panel on Climate Change (IPCC). 2005. *Special Report on Carbon Dioxide Capture and Storage*. Accessed December 10, 2006 at http://www.ipcc.ch/activity/srccs/index.htm (last updated January 16, 2006).

Mills, W. B., D. B. Porcella, M. J. Ungs, S. A. Gherini, K. V. Summers, L. Mok, G. L. Rupp, G. L. Bowie and D.A. Haith. 1985. "Water Quality Assessment: A Screening Procedure for Toxic and Conventional Pollutants in Surface and Ground Water." Volume 1. EPA/600/6-85/002a. U.S. Environmental Protection Agency, Washington, DC.

National Institute of Environmental Health Sciences (NIEHS). 1999. "Health Effects from Exposure to Power-Line Frequency Electric and Magnetic Fields." NIH Publication No. 99-4493.

National Institute of Occupational Health (NIOSH). 1983. *Comprehensive Safety Recommendations for Land-Based Oil and Gas Well Drilling Publication No. 83-127*. Accessed April 5, 2007 at http://www.cdc.gov/niosh/83-127.html

NIOSH. 1987. "Preventing Entrapment and Suffocation Caused by the Unstable Surfaces of Stored Grain and Other Material." NIOSH Publication No. 88-102.

NIOSH. 2007. *Pocket Guide to Chemical Hazards*. NIOSH Publication No. 2005-149. Accessed March 13, 2007 at http://www.cdc.gov/niosh/npg/npgsyn-a.html

Office of Pipeline Safety (OPS). 2006. *Hazardous Liquid Pipeline Accident Summary by Commodity*. 1/1/2006-12/05/2006. Accessed March 13, 2007 at http://ops.dot.gov/stats/LQ06_CM.HTM

OPS. 2007. *FOIA On-line Library*. Accessed March 12, 2007 at http://ops.dot.gov/stats/IA98.htm (last updated January 22, 2007).

Oldenburg, C. M. 2005. *Health, Safety, and Environmental Screening and Ranking Framework for Geologic CO_2 Storage Site Selection*. Accessed July 21, 2006 at http://repositories.cdlib.org/cgi/viewcontent.cgi?article=4279&context=lbnl

Papanikolau, N., B. M. L. Lau, W. A. Hobbs and J. Gale. 2006. "Safe Storage of CO_2: Experience from the Natural Gas Storage Industry." In *Proceedings of the 8th International Conference on Greenhouse Gas Control Technologies (GHGT-8)*, 19 - 22 June 2006. Trondheim, Norway.

Quest Consultants Inc. (Quest). 2006. "Consequence-Based Risk Ranking Study for the Proposed FutureGen Project Configurations." November 28, 2006. Norman, OK.

Scherer, G. W., M. A. Celia, J-H Prevost, S. Bachu, R. Bruant, A. Duguid, R. Fuller, S. E. Gasda, M. Radonijic and W. Vichit-Vadkan. 2005. "Leakage of CO_2 through Abandoned Wells: Role of Corrosion of Cement." In *Carbon Dioxide Capture for Storage in Deep Geologic Formations – Results from the CO_2 Capture Project, Vol 2 – Geologic Storage of Carbon Dioxide with Monitoring and Verification*. Elsevier Science, London.

Selgrade, M. K., R. F. Lemanske Jr., M. I. Gilmour, L. M. Neas, M. D.W. Ward, P. K. Henneberger, D. N. Weissman, J. A. Hoppin, R. R. Dietert, P. D. Sly, A. M. Geller, P. L. Enright, G. S. Backus, P. A. Bromberg, D. R. Germolec and K. B. Yeatts. 2006. "Induction of Asthma and the Environment: What We Know and Need to Know." *Environmental Health Perspectives* 114: 615-619.

TetraTech. 2007. "Final Risk Assessment Report for the FutureGen Project Environmental Impact Statement." April 2007 (Revised). Lafayette, CA.

Texas Westmoreland Coal Co. 2005. East Texas Electric Generating Facility Rules (Rule Log No. 2006-002-117-EN). Letter from M.K. Seglem (Vice President and General Manager) and J. Trouart (Vice President) to K. Hill, Air Quality Planning and Implementation Division, Texas Commission on Environmental Quality. December 7, 2005.

U.S. Bureau of Labor Statistics (USBLS). 2006a. *Incidence Rates of Nonfatal Occupational Injuries and Illnesses by Industry and Case Types*. Accessed November 10, 2006 at http://www.bls.gov/iif/oshwc/osh/os/ostb1619.pdf

USBLS. 2006b. *Fatal Occupational Injuries to Private Sector Wage and Salary Workers, Government Workers, and Self-employed Workers by Industry. All United States, 2005*. Accessed November 10, 2006 at http://www.bls.gov/iif/oshwc/cfoi/cftb0207.pdf

U.S. Department of Energy (DOE). 2002. "Major Environmental Aspects of Gasification-Based Power Generation Technologies." Final Report. December 2002. Washington, DC.

DOE. 2004. "ALOHA Computer Code Application Guidance for Documented Safety Analysis, Final Report." Report DOE-EH-4.2.1.3-ALOHA Code Guidance, June 2004, Office of Environment, Safety and Health, Washington, DC.

DOE. 2006. *Temporary Emergency Exposure Limits (TEELs) [Revision 21 of AEGLs, ERPGs and TEELs for Chemicals of Concern]*. Accessed March 13, 2007 at http://www.eh.doe.gov/chem_safety//teel.html (last updated on October 16, 2006).

DOE. 2007. *Final Environmental Impact Statement for the Orlando Gasification Project, January 2007*. Accessed March 8, 2007 at http://www.eh.doe.gov/NEPA/eis/eis0383/index.html

U.S. Environmental Protection Agency (EPA). 1995. "SCREEN3 Model User's Guide." EPA-454/B-95-004. Research Triangle Park, NC.

EPA. 2000. "Carbon Dioxide as a Fire Suppressant: Examining the Risks." EPA430-R-00-002. February 2000.

EPA. 2006a. *IRIS Database for Risk Information*. Accessed March 13, 2007 at http://www.epa.gov/iris/

EPA. 2006b. *Acute Exposure Guideline Levels (AEGLs)*. Accessed March 12, 2007 at http://www.epa.gov/oppt/aegl/pubs/chemlist.htm (last updated January 9, 2007).

EPA. 2007. *Acute Exposure Guideline Levels (AEGLs): Ammonia Results*. Accessed April 16, 2007 at http://www.epa.gov/oppt/aegl/pubs/results88.htm (last updated August 28, 2006).

6.18 Community Services

City Data (CD). 2002. *City Data*. Accessed December 1, 2006 at http://www.city-data.com/

Everett, L. 2004. *VA Losing the Ability to Care 'For Him Who Has Borne the Battle'*. Accessed November 30, 2006 at http://www.larouchepub.com/other/2004/3118v_a_hosptls.html

Everett, L. and M. M. Baker. 2004. *LaRouche: Reverse the Policy that Created the Flu Crisis*. Accessed November 30, 2006 at http://www.larouchepub.com/eiw/public/2004/2004_40-49/2004-42/pdf/04-13_41_ecoflu.pdf

FutureGen Alliance (FG Alliance). 2006c. "Heart of Brazos Site Environmental Information Volume."

National Center for Educational Statistics (NCES). 2005. *Public and Private Elementary and Secondary Teachers, Enrollment, and Pupil/Teacher Ratios: Selected Years, Fall 1955 through Fall 2014*. Accessed December 3, 2006 at http://nces.ed.gov/programs/digest/d05/tables/dt05_063.asp

Occupational Safety and Health Administration (OSHA). 1994. *Members of a HAZMAT Team.* Accessed December 3, 2006 at http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATIONS&p_id=21384

Quinlivan, J. T. 2003. *Burden of Victory: The Painful Arithmetic of Stability Operations*. Accessed December 2, 2006 at http://www.rand.org/publications/randreview/issues/summer2003/burden.html (last updated August 2, 2006).

Texas Comptroller of Public Accounts (CPA). 2006. *Major Challenges Facing Texas Education Today*. Accessed December 3, 2006 at http://www.cpa.state.tx.us/comptrol/wwstand/wws0512ed/

Texas Department of Public Safety (TDPS). 2003. *Texas Crime by Jurisdiction: Texas Crime Summary*. Accessed December 3, 2003 at http://www.txdps.state.tx.us/administration/crime_records/docs/cr2003/cit03ch9.pdf

Texas Education Agency (TEA). 2005. *Texas Public Schools: District and School Directory for County*. Accessed December 3, 2006 at http://askted.tea.state.tx.us/org-bin/school/SCHOOL_RPT?Y::County::Directory

Texas Fire Chiefs Association (TFCA). 2006. *Texas Fire Chiefs Association: Letter dated May 18, 2006*. Accessed December 3, 2006 at http://www.dshs.state.tx.us/emstraumasystems/StakeholderLetter.pdf

U.S. Census Bureau (USCB). 2006. *National Spending per Student Rises to $8,287*. Accessed November 29, 2006 at http://www.census.gov/Press-Release/www/releases/archives/economic_surveys/006685.html

USACOPS (UC). 2005. *Texas Police Departments*. Accessed December 1, 2006 at http://www.usacops.com/tx/pollist.html

6.19 Socioeconomics

FutureGen Alliance (FG Alliance). 2006c. "Heart of Brazos Site Environmental Information Volume."

Hotel-Online (HO). 2005. *Arlington Convention & Visitors Bureau Reports 2004. Increases in Hotel Occupancy and Average Daily Rate*. Accessed December 1, 2006 at http://www.hotel-online.com/News/PR2005_1st/Feb05_ArlingtonTX.html

Impact DataSource (IDS). 2004. *A Report of the Economic Impact of Ford Park in Beaumont, Texas*. Accessed December 2, 2006 at http://www.co.jefferson.tx.us/eco_dev/fordpark-economicimpactanalysis-full.pdf

U.S. Bureau of Labor Statistics (USBLS). 2006a. *Unemployment Rate (National Unemployment Rates 1996 to 2006)*. Accessed December 3, 2006 at http://data.bls.gov/PDQ/servlet/SurveyOutputServlet?data_tool=latest_numbers&series_id=LNS14000000

USBLS. 2006b. *Regional and State Employment and Unemployment: July 2006*. Accessed December 2, 2006 at http://www.bls.gov/news.release/archives/laus_08182006.pdf

U.S. Census Bureau (USCB). 2000a. *Projected Population of the United States, by Age and Sex: 2000 to 2050*. Accessed December 1, 2006 at http://www.census.gov/ipc/www/usinterimproj/natprojtab02a.pdf (last updated August 26, 2004).

USCB. 2000b. *Annual Estimates of the Population by Sex and Five-Year Age Groups for the United States: April 1, 2000 to July 1, 2005*. Accessed December 2, 2006 at http://www.census.gov/popest/national/asrh/NC-EST2005/NC-EST2005-01.xls (last updated June 8, 2006).

USCB. 2000c. *Median Age: 2000. Texas by County*. Accessed December 2, 2006 at http://factfinder.census.gov/servlet/ThematicMapFramesetServlet?_bm=y&-geo_id=04000US48&-tm_name=DEC_2000_SF1_U_M00022&-ds_name=DEC_2000_SF1_U&-_MapEvent=displayBy&-_dBy=050&-redoLog=false&-tm_config=|b=50|l=en|t=4001|zf=0.0|ms=thm_def|dw=10.50392852716582|dh=6.058983803831548|dt=gov.census.aff.domain.map.EnglishMapExtent|if=gif|cx=-89.504051|cy=39.739275000000006|zl=8|pz=8|bo=|bl=|ft=350:349:335:389:388:332:331|fl=403:381:204:380:369:379:368|g=04000US17|ds=DEC_2000_SF1_U|sb=50|tud=false|db=050|mn=27.5|mx=42.1|cc=1|cm=1|cn=5|cb=|um=Years|pr=1|th=DEC_2000_SF1_U_M00022|sf=N|sg=

USCB. 2000d. *Per Capita Income in 1999: 2000, Texas by County*. Accessed December 1, 2006 at http://factfinder.census.gov/servlet/ThematicMapFramesetServlet?_bm=y&-geo_id=04000US48&-tm_name=DEC_2000_SF3_U_M00270&-ds_name=DEC_2000_SF3_U&-_MapEvent=displayBy&-_dBy=050&-redoLog=false&-tm_config=|b=50|l=en|t=403|zf=0.0|ms=thm_def|dw=1.9557697048764706E7|dh=1.4455689123E7|dt=gov.census.aff.domain.map.LSRMapExtent|if=gif|cx=-1159354.4733499996|cy=7122022.5|zl=10|pz=10|bo=|bl=|ft=350:349:335:389:388:332:331|fl=403:381:204:380:369:379:368|g=01000US|ds=DEC_2000_SF3_U|sb=50|tud=false|db=040|mn=8185|mx=28766|cc=1|cm=1|cn=5|cb=|um=Dollars|pr=0|th=DEC_2000_SF3_U_M00270|sf=N|sg=

USCB. 2000e. *Median Household Income in 1999: 2000, Texas by County*. Accessed December 24, 2006 at http://factfinder.census.gov/servlet/ThematicMapFramesetServlet?_bm=y&-geo_id=04000US48&-tm_name=DEC_2000_SF3_U_M00024&-ds_name=DEC_2000_SF3_U&-_MapEvent=displayBy&-_dBy=050&-redoLog=false&-tm_config=|b=50|l=en|t=403|zf=0.0|ms=thm_def|dw=27.393417839603167|dh=17.698715125323893|dt=gov.census.aff.domain.map.EnglishMapExtent|if=gif|cx=-100.0765285|cy=31.170218499999997|zl=9|pz=9|bo=|bl=|ft=350:349:335:389:388:332:331|fl=403:381:204:380:369:379:368|g=04000US48|ds=DEC_2000_SF3_U|sb=50|tud=false|db=050|mn=7069|mx=33345|cc=1|cm=1|cn=5|cb=|um=Dollars|pr=0|th=DEC_2000_SF3_U_M00270|sf=N|sg=

USCB. 2000f. *Per Capita Income in 1999: 2000, United States by State*. Accessed December 1, 2006 at http://factfinder.census.gov/servlet/ThematicMapFramesetServlet?ds_name=DEC_2000_SF3_U&tm_name=DEC_2000_SF3_U_M00270&_dBy=040&geo_id=01000US&_MapEvent=displayBy

USCB. 2000g. *Median Household Income in 1999: 2000, United States by State*. Accessed December 1, 2006 at http://factfinder.census.gov/servlet/ThematicMapFramesetServlet?ds_name=DEC_2000_SF3_U&tm_name=DEC_2000_SF3_U_M00024&_dBy=040&geo_id=01000US&_MapEvent=displayBy

USCB. 2005a. *Population Pyramids of Texas*. Accessed December 1, 2006 at http://www.census.gov/population/projections/44PyrmdTX1.pdf (last updated April 20, 2005).

USCB. 2005b. *Texas: Physical Housing Characteristics for Vacant Housing Units*. Accessed December 1, 2006 at http://factfinder.census.gov/servlet/STTable?_bm=y&-geo_id=04000US48&-qr_name=ACS_2005_EST_G00_S2505&-ds_name=ACS_2005_EST_G00_&-redoLog=false

USCB. 2005c. *Texas: Industry by Sex and Median Earnings in the Past 12 Months (In 2005 Inflation-Adjusted Dollars) for the Civilian Employed Population 16 Years and Over*. Accessed December 1, 2006 at http://factfinder.census.gov/servlet/STTable?_bm=y&-geo_id=04000US48&-qr_name=ACS_2005_EST_G00_S2403&-ds_name=ACS_2005_EST_G00_&-redoLog=false

USCB. 2005d. *Percent of Occupied Housing Units that are Owner-Occupied: 2005. United States by State*. Accessed December 2, 2006 at http://factfinder.census.gov/servlet/ThematicMapFramesetServlet?_bm=y&-geo_id=01000US&-tm_name=ACS_2005_EST_G00_M00621&-ds_name=ACS_2005_EST_G00_&-_MapEvent=displayBy&-_dBy=040#?388,250

U.S. Government Printing Office (GPO). 2003. *General Decision: TX20030083 TX83 (Average Wages for Trades in Freestone, Leon and Limestone Counties, Texas)*. Accessed December 1, 2006 at http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=Davis-Bacon&docid=TX20030083

6.20 Environmental Justice

59 *Federal Register* 7629. "Executive Order Number 12898 – Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations." February 11, 1994. Federal Register [Volume 59, No. 32].

Council on Environmental Quality (CEQ). 1997. "Environmental Justice Guidance under the National Environmental Policy Act." Executive Office of the President. December 10, 1997. Washington, DC.

FutureGen Alliance (FG Alliance). 2006c. "Heart of Brazos Site Environmental Information Volume."

U.S. Census Bureau (USCB). 2006. *American FactFinder*. Accessed November 12, 2006 at http://factfinder.census.gov

U.S. Department of Energy (DOE). 2006. *Environmental Justice Definition*. Accessed November 12, 2006 at http://www.lm.doe.gov/env_justice/definition.htm (last updated December 13, 2006).

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