Draft
Environmental Impact Statement

for the

Proposed Abengoa Biorefinery Project
near Hugoton, Stevens County, Kansas

Volume 1 - Chapters

U.S. Department of Energy
Golden Field Office
Office of Energy Efficiency and Renewable Energy

DOE/EIS-0407D

September 2009

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COVER SHEET

RESPONSIBLE AGENCY: U.S. Department of Energy (DOE)

COOPERATING AGENCY: The U.S. Department of Agriculture-Rural Development is a cooperating agency in the preparation of the Abengoa Biorefinery Project EIS.

TITLE: *Draft Environmental Impact Statement for the Abengoa Biorefinery Project near Hugoton, Stevens County, Kansas* (DOE/EIS-0407D) (Abengoa Biorefinery Project EIS).

CONTACTS:

For more information about this document, write or call:
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy
Golden Field Office
1617 Cole Blvd.
Golden, CO 80401
ATTN: Ms. Kristin Kerwin
Telephone: (303) 275-4968
Fax: (303) 275-4790

For general information on the DOE National Environmental Policy Act (NEPA) process, write or call:
Carol M. Borgstrom, Director
Office of NEPA Policy and Compliance (GC-20)
U.S. Department of Energy
1000 Independence Avenue, S.W.
Washington, DC 20585
Telephone: (202) 586-4600
Or leave a message: (800) 472-2756

Information about this document is available on the Internet at the Abengoa Biorefinery Project Web site at http://www.biorefineryprojecteis-abengoa.com/ and on the DOE NEPA Web site at http://www.gc.energy.gov/NEPA.

ABSTRACT: DOE’s Proposed Action is to provide federal funding to Abengoa Bioenergy Biomass of Kansas, LLC (Abengoa Bioenergy) to support the design, construction, and startup of a commercial-scale integrated biorefinery to be located near the city of Hugoton, Stevens County, Kansas. If DOE decides to provide federal funding, it would negotiate an agreement with Abengoa Bioenergy to provide approximately $85 million of the total anticipated cost of approximately $300 million (2008 dollars). The biorefinery would use lignocellulosic biomass (corn stover, wheat straw) as feedstock to produce ethanol and biopower (electricity) sufficient to meet the needs of the biorefinery and produce excess electricity for sale to the regional power grid. DOE also evaluates an Action Alternative, under which the biorefinery would not produce excess electricity for sale to the regional grid, and a No-Action Alternative, under which the biorefinery would not be constructed. The draft Abengoa Biorefinery Project EIS evaluates the potential direct, indirect, and cumulative environmental impacts from the construction, operation, and decommissioning of the biorefinery.

PUBLIC COMMENTS: A 45-day public comment period on the draft Abengoa Biorefinery Project EIS begins with publication of the U.S. Environmental Protection Agency Notice of Availability in the *Federal Register*. DOE will consider all public comments postmarked or received during the public comment period. DOE will consider comments received after the 45-day period to the extent practicable. DOE will hold a public hearing to receive oral and written comments on the Draft EIS in Hugoton, Kansas at the date, time, and location announced in local media and in DOE’s Notice of Availability published in the *Federal Register*. Written comments also may be submitted by mail to DOE at the above address in Golden, Colorado; via the Internet, kristin.kerwin@go.doe.gov; or by facsimile (303) 275-4790.

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ACRONYMS AND ABBREVIATIONS

To ensure a more reader-friendly document, the U.S. Department of Energy (DOE or the Department) limited the use of acronyms and abbreviations in this Biorefinery Project EIS. In addition, acronyms and abbreviations are defined the first time they are used in each chapter. The acronyms and abbreviations used in the text of this document are listed below.

ABBK	Abengoa Bioenergy Biomass of Kansas (also called Abengoa Bioenergy)
AERMOD	American Meteorological Society/EPA Regulatory Model
°C	degrees Celsius
CFR	Code of Federal Regulations
CRP	Conservation Reserve Program
dBA	A-weighted decibels
DOE	U.S. Department of Energy (also called the Department)
EIS	environmental impact statement
EPAct 2005	*Energy Policy Act of 2005*
EPA	U.S. Environmental Protection Agency
°F	degrees Fahrenheit
FR	*Federal Register*
GREET	Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (Model)
K.A.R.	Kansas Administrative Regulation
NRCS	Natural Resources Conservation Service
NEPA	*National Environmental Policy Act*, as amended
PM_{10}	particulate matter with an aerodynamic diameter of 10 micrometers or less
$PM_{2.5}$	particulate matter with an aerodynamic diameter of 2.5 micrometers or less
U.S.C.	United States Code
USDA	United States Department of Agriculture
USGS	United States Geological Survey

TERMS AND DEFINITIONS

In this Biorefinery Project EIS, DOE has italicized terms that appear in the Glossary (Chapter 10) the first time they appear in a chapter.

UNDERSTANDING SCIENTIFIC NOTATION

DOE has used scientific notation in this Biorefinery Project EIS to express numbers that are so large or so small that they can be difficult to read or write. Scientific notation is based on the use of positive and negative powers of 10. The number written in scientific notation is expressed as the product of a number between 1 and 10 and a positive or negative power of 10. Examples include the following:

Positive Powers of 10	Negative Powers of 10
$10^1 = 10 \times 1 = 10$	$10^{-1} = 1/10 = 0.1$
$10^2 = 10 \times 10 = 100$	$10^{-2} = 1/100 = 0.01$
and so on, therefore,	and so on, therefore,
$10^6 = 1{,}000{,}000$ (or 1 million)	$10^{-6} = 0.000001$ (or 1 in 1 million)

Probability is expressed as a number between 0 and 1 (0 to 100 percent likelihood of the occurrence of an event). The notation 3×10^{-6} can be read 0.000003, which means that there are 3 chances in 1 million that the associated result (for example, a fatal cancer) will occur in the period covered by the analysis.

Chapter 1

Introduction and Purpose and Need

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1. INTRODUCTION AND PURPOSE AND NEED

The U.S. Department of Energy (DOE or the Department) is proposing to provide federal funding to Abengoa Bioenergy Biomass of Kansas, LLC (Abengoa Bioenergy) to support the final design, construction, and startup of a *biomass*-to-ethanol and biomass-to-energy production facility (hereafter referred to as the Abengoa Biorefinery Project). If the Department decides to provide federal funding, it would negotiate an agreement with Abengoa Bioenergy to provide approximately $85 million (2008 dollars) for the final design, construction, and startup of the biorefinery, whose total anticipated cost is approximately $300 million (2008 dollars).

> **BIOREFINERY**
>
> Biorefineries are similar to petroleum refineries in concept; however, biorefineries use biological matter (biomass) as *feedstock* (raw materials), instead of petroleum feedstock, to produce transportation fuels (for example ethanol), industrial chemicals, and heat and power. Such transportation fuels, industrial chemicals, and heat/power are referred to as *biofuels*, *bioproducts*, and *biopower*, respectively.
>
> An integrated biorefinery uses combinations of biomass feedstocks (for example, corn stover, wheat straw, and other nonfood crop residues) and conversion technologies to produce a variety of products, but typically biofuels.
>
> In this EIS, the term “biorefinery” refers to the physical structures, including associated infrastructure, of the biomass-to-ethanol and biomass-to-energy production facility.

The *Biorefinery Project site* would be located adjacent to and west of the city of Hugoton, in Stevens County, Kansas (Figure 1-1). Land use in the area is primarily agricultural with cropland as the dominant use and *grassland* as the secondary use. Various grains are grown in the area, providing a diversity of biomass feedstocks and supplying food for large cattle feedlots in the vicinity.

The Biorefinery Project site, comprising approximately 810 acres (3.3 square kilometers) of row-cropped agricultural land, is within an area bordered on the south by U.S. Highway 56/Kansas State Highway 51, County Road 10 to the west, Rural Road P to the north, and Rural Road 12, which is east of the Project site along the western side of Hugoton (KDOT 2008). Grain elevators, an asphalt plant, and an industrial park are located nearby. There is an airport to the south, a golf course and agricultural land to the west, two residences to the northwest, agricultural cropland to the north, and the city of Hugoton (population approximately 3,700) to the east (Figure 1-2). The *biorefinery* would be developed on the western 385 acres (1.6 square kilometers) of the Project site (hereafter referred to as the *biorefinery area* or parcel), and the remaining 425 acres (1.7 square kilometers) would act as a *buffer* between the biorefinery and the city of Hugoton (hereafter referred to as the buffer area or parcel).

In accordance with DOE [Title 10 of the *Code of Federal Regulations* (CFR) Part 1021] and the Council on Environmental Quality regulations (40 CFR Parts 1500 through 1508) that implement the *National Environmental Policy Act* [NEPA; 42 U.S.C. 4321-4370(f)], DOE is required to evaluate the potential environmental impacts of its proposal, whether initiated by DOE or an applicant, because DOE’s funding decision in this instance would constitute a major federal action. Since DOE must decide whether to use federal funds to support the Abengoa Biorefinery Project, it has prepared this *Draft Environmental Impact Statement for the Proposed Abengoa Biorefinery Project near Hugoton, Stevens County, Kansas* (DOE/EIS-0407D) (Abengoa Biorefinery Project EIS) to evaluate the potential environmental impacts of the *Proposed Action*, Action Alternative, and No-Action Alternative.

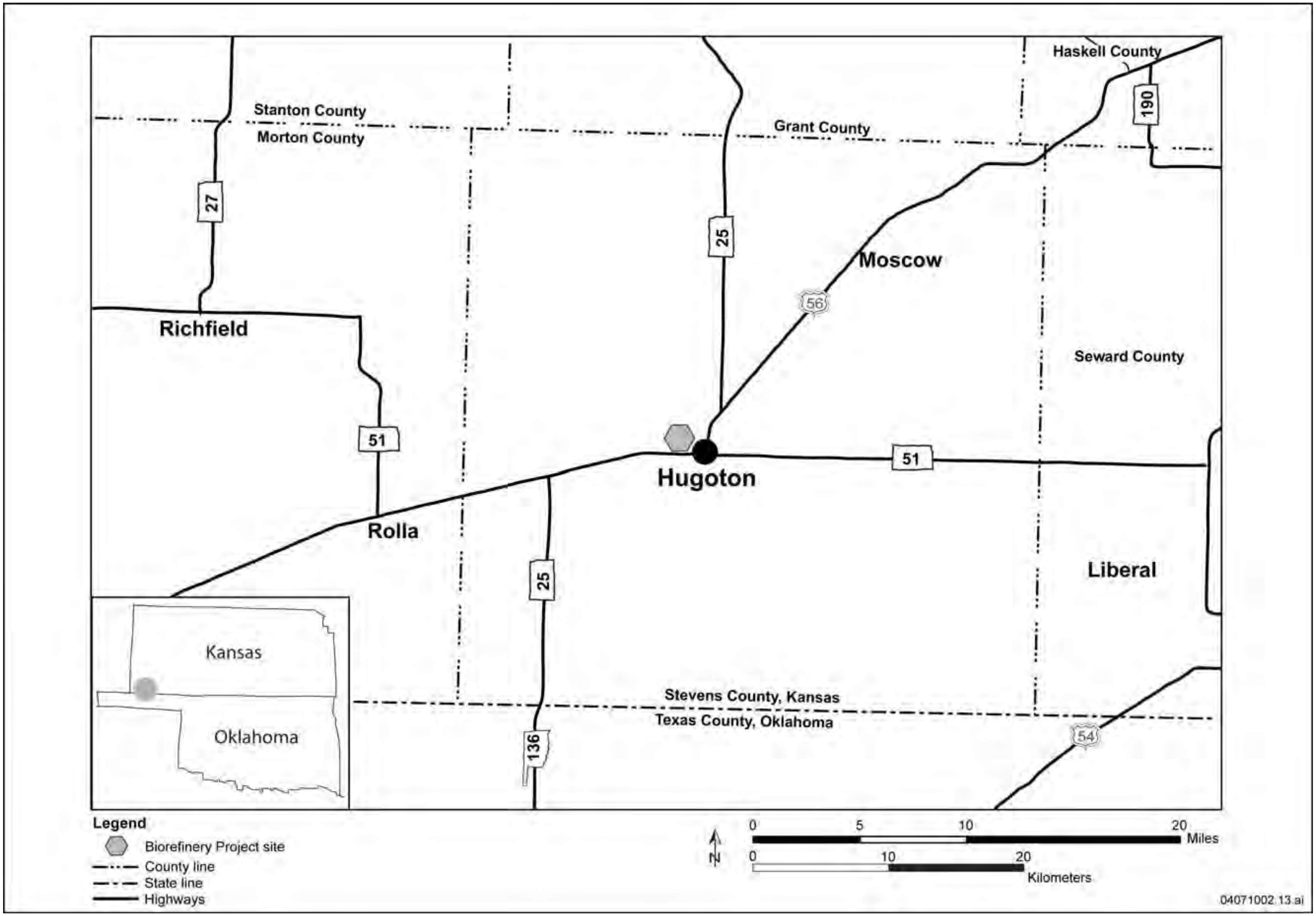

Figure 1-1. Biorefinery Project site.

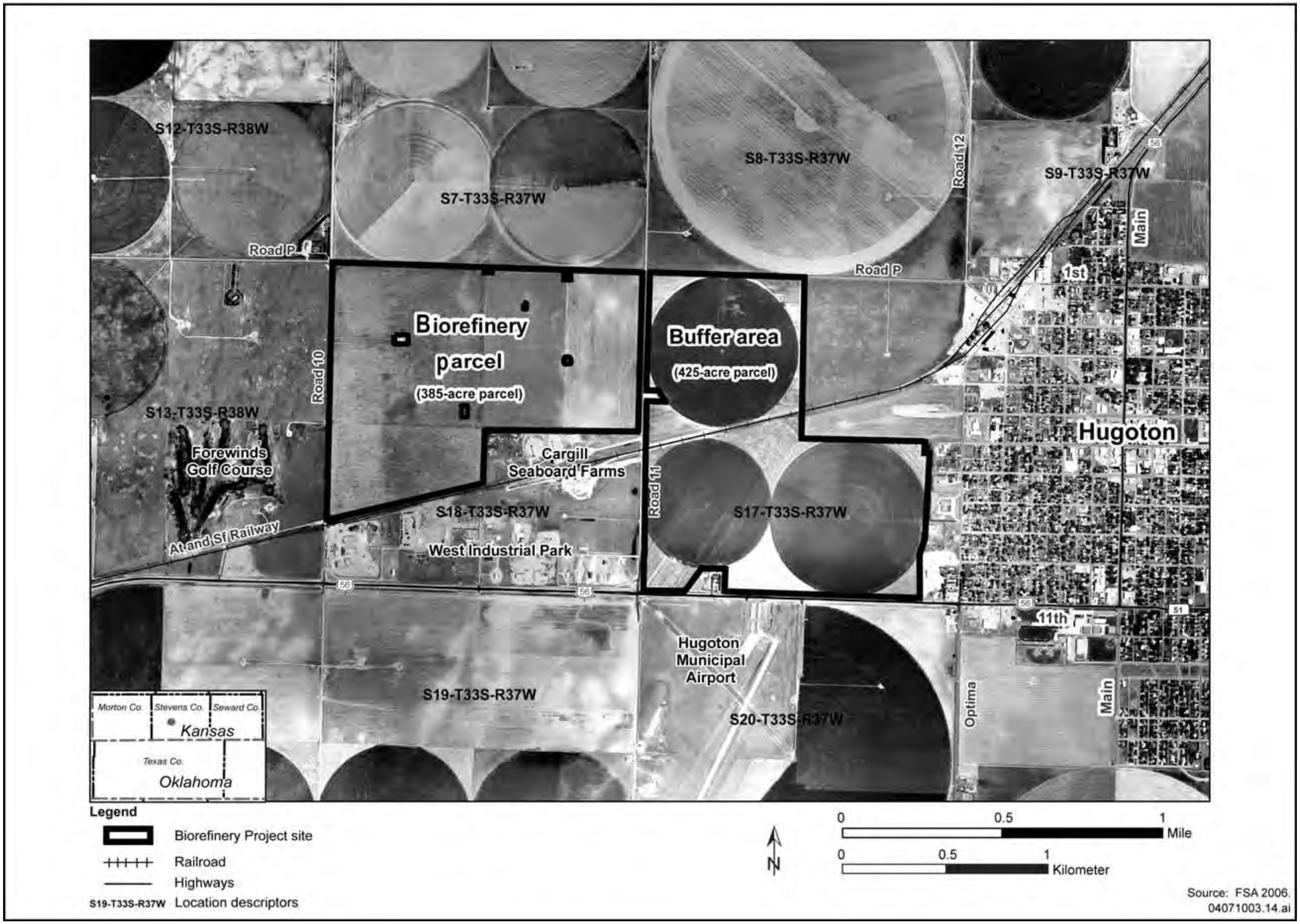

Figure 1-2. Biorefinery Project site and vicinity.

1.1 Purpose and Need

The *Energy Policy Act of 2005* (EPAct 2005), Section 932, directs the Secretary of Energy to conduct a program of research, development, demonstration, and commercial application for bioenergy, including integrated biorefineries that can produce biopower, biofuels, and bioproducts. In carrying out a program to demonstrate the commercial application of integrated biorefineries, EPAct 2005 authorizes the Secretary to provide funds to biorefinery demonstration projects proposed by industry and encourages the use of such funds to demonstrate the efficacy of producing biofuels from a wide variety of *lignocellulosic feedstocks*; the commercial application of biomass technologies for a variety of uses, including the development of biofuels, bio-based *chemicals*, substitutes for petroleum-based feedstocks and products, and electricity or useful heat; and the collection and treatment of a variety of biomass feedstocks. The Department's goal in implementing Section 932 of EPAct 2005 is to demonstrate that commercial-scale integrated biorefineries that use a wide variety of lignocellulosic feedstocks can operate without direct federal subsidy after construction costs are paid, and that these biorefineries can be easily replicated.

LIGNOCELLULOSIC FEEDSTOCK

Any portion of a plant or a *byproduct* used by the conversion of organic materials to energy, including crops, trees, forest wastes, and agricultural wastes not specifically grown for food. These would include, for example, barley grain, grapeseed, rice bran and hulls, soybean matter, corn stover, and organic materials that have been segregated from municipal *solid waste*.

Lignocellulosic (cellulosic) feedstocks would not include, for example, plant-based oils intended for human consumption, such as soy, canola, sunflower and peanut oils, or foods intended for human and animal consumption, such as corn.

In his 2006 State of the Union Address, President George W. Bush introduced the Advanced Energy Initiative, which included increased funding to research advanced biofuel production processes. In early 2007, President Bush announced the "Twenty-in-Ten" Initiative, a plan to reduce gasoline consumption by 20 percent in 10 years (USDA and DOE 2008).

In response, Congress passed, and the President signed into law, the *Energy Independence and Security Act of 2007*. This Act included a Renewable Fuel Standard that requires the production of 36 billion gallons (136 billion liters) per year of biofuels by 2022, and included specific provisions for advanced biofuels, such as *cellulosic ethanol* and biomass-based diesel fuels.

In consideration of these requirements, DOE and the U.S. Department of Agriculture (USDA) published the *National Biofuels Action Plan* (USDA and DOE 2008), the purpose of which is to identify actions needed to ensure development of viable alternatives to petroleum-based fuels to meet the Renewable Fuel Standard. This Plan discusses the need to achieve improvements in the production of first- and second-generation feedstocks over the near and longer term to sustain growth in the biofuels industry. First-generation feedstocks include, for example, corn for the production of ethanol and soybeans for the production of biodiesel. Although production of these crops has been increasing, DOE and USDA also recognize the need to avoid disrupting the production of crops for human and animal consumption. The Plan also recognizes a need to enhance the production and use of second-generation feedstocks, which consist of the residues from crops and forest harvests (lignocellulosic feedstocks).

Accordingly, DOE's purpose and need is to support the development of commercial-scale, integrated biorefineries and the demonstration of the use of a wide variety of cellulosic feedstocks in the production of biofuels, bio-based chemicals, and biopower.

1.2 Background

Under EPAct 2005, Congress directed the Department to carry out a program to demonstrate the commercial application of integrated biorefineries for the production of biofuels, in particular ethanol, from lignocellulosic feedstocks. Federal funding for cellulosic ethanol production facilities is intended to further the government's goal of rendering ethanol cost-competitive with gasoline by 2012, and along with increased automobile fuel efficiency, reducing gasoline consumption in the United States by 20 percent within 10 years.

Accordingly, in February 2006, DOE issued a funding opportunity announcement for the design and construction of commercial-scale integrated biorefineries intended to demonstrate the use of a wide variety of lignocellulosic feedstocks to produce combinations of liquid transportation fuels (biofuels), bio-based chemicals, substitutes for petroleum-based feedstocks and products, and energy in the form of electricity or useful heat (biopower). In that announcement, DOE also encouraged the use of a wide variety of lignocellulosic feedstocks, but not those biomass components specifically grown for food, and encouraged the use of various technologies to collect and treat the wide variety of biomass feedstocks.

On February 28, 2007, the Department, after reviewing proposals from industry, announced the selection of six biorefinery projects for negotiation of financial assistance awards (DOE 2007). In that announcement, DOE proposed to invest up to $385 million in these projects over the next 4 years.

Abengoa Bioenergy was one of six applicants selected for negotiation of award. Abengoa proposed an innovative approach to biorefinery operations that would involve production of a biofuel and energy in the form of steam that can be used to meet energy needs and displace fossil fuels, such as coal and natural gas. The proposal also included an integrated grain-to-ethanol facility. In addition, Abengoa proposed to site the facility in Kansas to qualify for state tax credits for the construction of cellulosic ethanol facilities (*Kansas Energy Development Act of 2006*; Kansas Senate Bill 303), which would make the biorefinery a more viable commercial operation.

DOE granted an initial award of about $15 million to Abengoa Bioenergy to advance the conceptual design, initiate the process to obtain necessary permits and approvals, and support an environmental review under NEPA for the proposed biomass-to-ethanol and biomass-to-energy production facility. DOE required that Abengoa fulfill these design, regulatory compliance, and environmental review obligations prior to deciding whether to fund, in part, the construction and startup of the proposed biorefinery.

The Department initiated the environmental review process with its August 2008 "Notice of Intent to Prepare an Environmental Impact Statement and Notice of Wetlands Involvement for the Abengoa Biorefinery Project Near Hugoton, KS" (73 FR 50001, August 25, 2008) (public scoping is described in greater detail in Section 1.4). In January 2009, because of economic viability and anticipated market conditions, Abengoa Bioenergy notified DOE that it no longer was considering the construction and operation of the traditional grain-to-ethanol facility, and was proposing to modify its biomass-to-ethanol and biomass-to-energy production facility by including a steam-driven turbine to generate electricity that would exceed the electrical demands of the proposed biorefinery (the excess electricity would be supplied to the regional power grid). In addition, Abengoa decided to solicit loan guarantees from the Department's Loan Guarantee Program pursuant to Title XVII of EPAct 2005 and from the USDA Rural Development Biorefinery Assistance Program pursuant to Section 9003 of the *Food, Conservation, and Energy Act of 2008* (the USDA Program is discussed in greater detail in Section 1.3).

Title XVII of EPAct 2005 provides broad authority to DOE to guarantee loans that support early commercial use of advanced technologies, if there is reasonable prospect of repayment of the principal and interest on the obligation by the borrower (in this instance, Abengoa Bioenergy). The Department's Loan Guarantee Program targets accelerated commercial use of new or improved technologies to help sustain economic growth, yield environmental benefits, and produce a more stable and secure energy supply. DOE published "Guidelines for the Loan Guarantee Program" (71 FR 46451, August 14, 2006) and issued a solicitation announcement in August 2006, inviting interested parties to submit project proposals that meet the Title XVII statutory requirements and also contribute to goals of the President's Advanced Energy Initiative. Since that time, the Department has published additional solicitations, and on February 26, 2009 Abengoa filed an application with DOE's Loan Guarantee Program for the proposed biorefinery.

The Department considered Abengoa Bioenergy's proposed project changes and application for a loan guarantee, and concluded that the project remains eligible for federal funding under Section 932 of EPAct 2005. On August 28, 2009, the Department determined, however, that it will not proceed with Abengoa's request for a loan guarantee.

Accordingly, the Department is now proposing to negotiate a second agreement to provide federal funding to support the final design, construction, and startup of the Abengoa Biorefinery Project. If DOE decides to provide federal funding to Abengoa, DOE will do so under the provisions of the *American Recovery and Reinvestment Act of 2009*.[1]

Based, in part, on the analyses in this Abengoa Biorefinery Project EIS, DOE will decide (1) whether to provide funding to support the final design, construction, and startup of the Biorefinery Project as proposed by Abengoa Bioenergy; (2) whether to provide funding to support the final design, construction, and startup of the Biorefinery Project for all elements of the facility as proposed by Abengoa, except for the portion dedicated to generating electricity for commercial sale (the Action Alternative); or (3) whether to provide funding for either the Proposed Action or Action Alternative, contingent on the implementation of environmental *mitigation* measures, which would be determined based on the environmental impact analysis in this EIS.

1.3 Cooperating Agency—U.S. Department of Agriculture Rural Development

The Council on Environmental Quality regulations (40 CFR 1501.6) emphasize agency cooperation early in the NEPA process and allow a lead agency (in this instance, DOE) to request the assistance of other

1. The purpose of the *American Recovery and Reinvestment Act of 2009*, which was enacted into law on February 17, 2009, is to provide federal funds for job preservation and creation, infrastructure investment, energy efficiency and science, assistance to the unemployed, and state and local fiscal stabilization. The Act is commonly known as the "Stimulus Bill."

agencies that either have jurisdiction by law or have special expertise regarding issues considered in an EIS. USDA Rural Development is a cooperating agency in the preparation of this EIS.

USDA Rural Development is an agency within the USDA. The role of Rural Development is to increase economic opportunities for rural residents and improve their quality of life by forging partnerships with rural communities; funding projects that bring housing, community facilities, utilities, and other services; and by providing technical assistance and financial backing for rural businesses and cooperatives to create jobs in rural areas. USDA Rural Development maintains general responsibility for renewable energy and energy-efficient improvements programs, one of which is the Biorefinery Assistance Program.

The purpose of the Biorefinery Assistance Program, as established by Section 9003 of the *Food, Conservation, and Energy Act of 2008* (2008 Farm Bill), is to assist in the development of new and emerging technologies for the development of advanced biofuels to:

1. Increase the energy independence of the United States;
2. Promote resource conservation, public health, and the environment;
3. Diversify markets for agricultural and forestry products and agriculture waste material; and
4. Create jobs and enhance the economic development of the rural economy.

Section 9003 of the 2008 Farm Bill is intended to assist in the development and construction of commercial-scale biorefineries and the retrofitting of existing facilities using *eligible technology* for the development of advanced biofuels. Eligible technology is (a) any technology that is being adopted in a viable commercial-scale operation of a biorefinery that produces an advanced biofuel, and (b) any technology not described in (a) that has been demonstrated to have technical and economic potential for commercial application in a biorefinery that produces an advanced biofuel.

Consistent with Congressional intent, projects where first-of-a-kind technology will be deployed at the commercial scale receive preference. To that end, the Biorefinery Assistance Program promotes the development of the first commercial-scale biorefineries that do not rely on corn kernel starch as the feedstock or standard biodiesel technology. USDA Rural Development will make guarantees available on loans for eligible projects that provide for the development, construction, and/or retrofitting of commercial biorefineries using eligible technology. Further, projects must be located in a rural area and be for either (1) the development and construction of commercial-scale biorefineries using eligible technology, or (2) the retrofitting of existing facilities, including, but not limited to, wood products facilities and sugar mills, with eligible technology.

USDA Rural Development agreed to be a cooperating agency in the preparation of this Abengoa Biorefinery Project EIS to enable Rural Development to use the environmental analyses of the EIS as part of its overall evaluation of Abengoa Bioenergy for a loan guarantee for the proposed biorefinery. Although Abengoa submitted its application for a loan guarantee to USDA Rural Development on April 29, 2009, it was not approved for funding in Fiscal Year 2009. Should Abengoa submit an application for a loan guarantee in future years, Rural Development will use this EIS as part of its evaluation of project eligibility and sufficiency and will make a determination of the relevancy of the information at that time.

1.4 National Environmental Policy Act Process

The Council on Environmental Quality and DOE regulations that implement NEPA require that DOE, as a federal agency:

- Assess the potential environmental impacts of its proposed actions,
- Identify any adverse environmental effects that cannot be avoided,
- Evaluate alternatives to the Proposed Action, including a No-Action Alternative,
- Describe the relationship between local, short-term uses of the environment and the maintenance and enhancement of long-term productivity, and
- Characterize any irreversible and irretrievable commitments of resources.

DOE must meet these requirements before a final agency decision is made to proceed with any proposed federal action that could cause significant impacts to human health or the environment. This Abengoa Biorefinery Project EIS is intended to meet DOE's regulatory requirements under NEPA, and provide DOE and other state and federal agency decisionmakers with information needed to make informed decisions in connection with the construction and startup of the Abengoa Biorefinery Project.

1.4.1 NOTICE OF INTENT AND PUBLIC SCOPING MEETING

On August 25, 2008, DOE published in the *Federal Register* its "Notice of Intent to Prepare an Environmental Impact Statement and Notice of Wetlands Involvement for the Abengoa Biorefinery Project Near Hugoton, KS" (73 FR 50001). The Department also published on September 8, 2008, a press release that was provided to eight newspapers and four radio stations in southwestern Kansas. DOE issued the notice and press release to inform the public about the Proposed Action and alternatives, announce plans to conduct a public scoping meeting, invite public participation in the scoping process, and solicit public comments for consideration in establishing the scope of the Abengoa Biorefinery Project EIS, including the range of reasonable alternatives and the potential environmental impacts to be analyzed. The public scoping period began on August 25, 2008, and ended on October 9, 2008. A public scoping meeting was held in Hugoton, Kansas, on September 10, 2008.

PUBLIC NOTICES

On September 2, 2008, DOE mailed notices of the upcoming public scoping meeting related to the Notice of Intent to more than 60 federal and state agencies, American Indian tribes, elected officials, commercial enterprises, and the public.

On May 12, 2009, DOE mailed notices of the upcoming public scoping meeting related to the amended Notice of Intent to more than 60 federal and state agencies, American Indian tribes, elected officials, commercial enterprises, and the public.

1.4.2 AMENDED NOTICE OF INTENT AND PUBLIC SCOPING MEETING

On April 29, 2009, DOE published in the *Federal Register* its “Amended Notice of Intent to Modify the Scope of the Environmental Impact Statement for the Abengoa Biorefinery Project near Hugoton, KS” (74 FR 19543). The Department also published on May 14, 2009, a press release that was provided to eight newspapers and four radio stations in southwestern Kansas. DOE issued the amended notice and press release to inform the public about changes in the Abengoa Biorefinery Project relevant to the scope of the ongoing EIS, announce plans to conduct a public scoping meeting, invite public participation in the scoping process, and solicit public comments for consideration in establishing the scope of the EIS, including the range of reasonable alternatives and the potential environmental impacts to be analyzed. The public scoping period began on April 29, 2009, and ended on May 29, 2009. A public scoping meeting was held in Hugoton, Kansas, on May 19, 2009.

1.4.3 SCOPING COMMENTS

The Department received both oral and written scoping comments. Oral comments were documented by a court reporter at the public meetings on September 10, 2008 and May 19, 2009. In response to the first scoping period, DOE received three letters and two emails. Each of the six comment documents (including transcripts from the September 10^{th} meeting) was given a unique document number, and each was then reviewed to identify comments; comments were numbered sequentially (for example, 1, 2, 3) in the margins of each document. DOE identified 14 scoping comments and grouped them into three categories reflecting the nature of the individual comments. The comments are documented in *Summary of Public Scoping Comments for the Environmental Impact Statement for the Abengoa Biorefinery near Hugoton, Kansas* (DOE 2008).

In response to the second scoping period, DOE received two letters and produced a transcript of oral comments received during the May 19^{th} meeting. Each of the three comment documents was reviewed, and DOE identified two new comments (the documents also reiterated comments submitted previously in response to the first scoping period).

The three categories and a summary of the comments in each category are described below.

Category 1: Support for the project

Nine Stevens County governmental and local organization representatives and members of the public voiced support for the proposed project, citing the financial benefits to the community and its residents.

Category 2: Request for specific information or analyses

- The U.S. Army Corps of Engineers requested a location map and an assessment of potential impacts to waters of the United States.

- The USDA Natural Resources Conservation Service requested analyses of biomass production and harvesting impacts to soils, surface and *groundwater* quality and quantity, *air quality*, and upland wildlife habitat. The Natural Resources Conservation Service also requested an assessment of cropping practices, cropping rotations, and crop yields regarding potential availability and removal of biomass. The Conservation Service further requested assessments of biomass removal impacts to assess any potential impacts to existing federal programs and acts including the *Conservation Reserve*

Program, Conservation Security Program, Environmental Quality Incentives Program, and the *1985 Food Security Act's* Highly Erodible Land Provision.

- The U.S. Fish and Wildlife Service requested evaluation of potential impacts to the lesser prairie-chicken, migratory birds, and stream water quality and quantity, as well as changes in landscape/native habitats from the possible conversion of native grassland to crop production. The Service requested that DOE consult with the Kansas Department of Wildlife and Parks regarding possible impacts to State-listed threatened or endangered species. The Service also recommended that new and permanent transmission lines conform to designs shown to mitigate bird collisions, specifically raptors.

- The Kansas State Historical Society, State Historic Preservation Officer requested that DOE conduct a *cultural resources* survey of a shallow *playa* basin area located within and adjacent to the Project site prior to beginning construction.

- Members of the public (one comment from two individuals) requested information relative to impacts from odor, dust, and parked train cars.

Category 3: Statements of no negative environmental impacts

The Kansas Department of Agriculture, Division of Water Resources indicated that the proposed project would not have negative environmental impacts in terms of water use, and that the potential benefits are great.

In response to the public scoping comments, the Department conducted a cultural resources survey of the playa basin area as requested by the Kansas State Historical Society, State Historic Preservation Officer, and a *wetlands* survey as requested by the U.S. Army Corps of Engineers. DOE also assessed biomass removal to estimate potential environmental impacts and analyze effects to existing federal programs and acts, including the Conservation Reserve Program, Conservation Security Program, Environmental Quality Incentives Program, and the *1985 Food Security Act's* Highly Erodible Land Provision. The Department also evaluated potential impacts to waters of the United States, as well as socioeconomic, air quality, soil, and traffic and transportation impacts in this Abengoa Biorefinery Project EIS.

Based on coordination with the U.S. Fish and Wildlife Service, potential impacts to the lesser prairie chicken were assessed, as was the potential conversion of native grasslands and *Conservation Reserve Program* lands to cropland. The Kansas Department of Wildlife and Parks also was consulted regarding possible impacts to State-listed species.

In addition to the above actions, DOE consulted with Abengoa Bioenergy regarding the status of the design of the proposed biorefinery and undertook preliminary analyses of various options for implementing the proposed project. At the time of the second public scoping period, which closed on May 19, 2009, DOE anticipated the proposed biorefinery would process up to 1,700 dry short tons (1,500 dry metric tons) of biomass per day to produce about 12 million gallons (45 million liters) of ethanol per year, *syngas* (another biofuel comprising a mixture of carbon monoxide, hydrogen, and other hydrocarbons), and about 60 megawatts of electricity. Based on a refined and optimized design, and as analyzed under the Proposed Action in this Abengoa Biorefinery Project EIS, DOE anticipates the proposed biorefinery would use up to 2,500 dry short tons (2,300 dry metric tons) of biomass per day to produce up to 18 million gallons (68 million liters) of ethanol per year and about 92 megawatts of electricity; syngas would no longer be produced (the production of syngas is analyzed, however, under the Action Alternative).

DOE initally also considered evaluating in detail options for implementing the proposed project; these options, which were described in the Amended Notice of Intent, included onsite versus offsite storage of biomass; wet (unprotected or uncovered) versus dry (protected or covered) biomass storage; and smaller or larger boiler sizes. Initial analysis, however, of wet versus dry storage and onsite versus offsite storage did not identify any meaningful environmental differences, and, therefore, no further analysis was performed. DOE also decided to eliminate any evaluation of a range of boiler sizes in favor of including the appropriate-sized boiler(s) based upon the biorefinery designs considered under the Proposed Action and Action Alternative.

1.5 Organization of this EIS

This Abengoa Biorefinery Project EIS evaluates the potential direct, indirect, and cumulative environmental impacts of the Proposed Action, an Action Alternative, and a No-Action Alternative; Chapter 2 describes these alternatives and summarizes the potential environmental impacts. Chapter 3 describes the *affected environment* (baseline environmental conditions) for 13 resources areas (for example, air quality, cultural resources, and *hydrology*). Chapter 4 describes the potential direct and indirect environmental impacts to these resources. Chapter 5 describes the potential cumulative environmental impacts of the Proposed Action and alternatives. Chapter 6 describes potential mitigation measures to be considered relative to implementation of the Proposed Action and Action Alternative. Chapter 7 identifies unavoidable impacts associated with implementation of the Proposed Action and Action Alternative. Chapter 8 lists the regulations applicable to the construction and operation of the proposed biorefinery. Chapter 9 provides the list of preparers, Chapter 10 provides a glossary, and Chapter 11 is the document index. Appendices, which provide additional details in support of the various chapters, address biorefinery facilities and operational processes, procurement of biomass, surface and groundwater resources, wetlands, cultural resources, air quality, additional environmental data used in the analyses, details of the Department's public participation activities, *Federal Register* notices, and the EIS distribution list.

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Chapter 2

Proposed Action and Alternatives

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2. PROPOSED ACTION AND ALTERNATIVES

The Department of Energy (DOE or Department) is proposing to provide federal funding of approximately $85 million to Abengoa Bioenergy Biomass of Kansas, LLC (Abengoa Bioenergy) to support the design, construction, and startup of the Abengoa Biorefinery Project (the total anticipated cost of the biorefinery is approximately $300 million). This *biorefinery* would use lignocellulosic *biomass* (biomass) as feedstock to produce *biofuels* and *biopower* at a facility proposed to be located near Hugoton, Kansas (Chapter 1, Figure 1-1). DOE has prepared this EIS to evaluate the potential environmental impacts of the construction, operation, and decommissioning of the biorefinery. The U.S. Department of Agriculture-Rural Development is a cooperating agency in the preparation of this EIS.

FERMENTATION

Ethanol *fermentation* is the biological process of bacteria and yeast breaking down simple sugars for their cellular energy and producing ethanol and carbon dioxide.

In a traditional grain-to-ethanol facility, biofuel producers *ferment* the simple sugars contained in grains such as corn and milo (grain sorghum) to produce ethanol. Instead, in the biorefinery proposed by Abengoa Bioenergy, biomass, such as wheat straw, milo stubble, switchgrass, corn stover, and other available materials, would be harvested as feedstock and fermented to produce ethanol (Figure 2-1).

Abengoa Bioenergy would ferment the simple sugars contained in the cell walls of the feedstock. Roughly two-thirds of the feedstock is present as *cellulose* and *hemicellulose* (the two main components of plants that give them structure), and *lignin* makes up the bulk of the remaining dry mass.

Figure 2-1. Corn stover in the field after corn harvest.

Cellulose hydrolysis involves breaking down the cellulose into simple fermentable sugars. Acids and enzymes are used for cellulose hydrolysis. After the cell walls are broken down into fermentable sugars, yeast or bacteria are mixed with the sugars. Yeast or bacteria feed on the sugars and produce ethanol and carbon dioxide. The ethanol is distilled to remove most of the water and residual solids; the living yeast or bacteria are destroyed as well. Lignin is the major *byproduct* of the fermentation process.

Bioenergy, or biopower, is the use of biomass to generate electricity. Bioenergy system technologies include *direct-firing*, *co-firing*, *gasification*, *pyrolysis*, and *anaerobic digestion*. Direct-firing uses biomass as solid fuel in biomass boilers to produce steam. Gasification occurs when biomass is heated in a low-oxygen environment, producing a biofuel known as *syngas*. Pyrolysis is a special kind of *chemical* breakdown using heat that does not require oxygen the way direct firing does. The result of pyrolysis is syngas. Anaerobic digestion is a series of processes in which microorganisms break down biodegradable material in the absence of oxygen. It is a renewable energy source because the process produces a methane- and carbon dioxide-rich biogas. Most bioenergy plants use direct-fired systems in that they burn biomass *feedstocks* directly to produce steam. This steam drives a turbine, which turns a generator that converts the power into electricity. In some biomass industries, the spent steam from the power plant is used for manufacturing processes or to heat buildings. Such combined heat and power systems greatly increase overall energy efficiency.

The remainder of this chapter describes the *Proposed Action* and Alternatives. *Best management practices* are integral to the design, construction, and startup of the biorefinery. If a best management practice is important to understanding the design of the biorefinery it is described in this chapter.

BEST MANAGEMENT PRACTICES

The practices, techniques and methods, and processes and activities commonly accepted and used throughout the construction and ethanol and energy production industries to facilitate compliance with applicable requirements, and that provide an effective and practicable means of avoiding or reducing the potential environmental impacts of the Proposed Action and Action Alternative.

Best management practices are presented in greater detail in Chapter 6. Section 2.1 discusses the Proposed Action, Section 2.2 discusses the Action Alternative, Section 2.3 discusses the No-Action Alternative, Section 2.4 provides a comparison of the key design features between the Proposed Action and Action Alternative, Section 2.4 summarizes the findings of this EIS, and Section 2.5 discusses alternatives considered but eliminated from detailed consideration.

2.1 Proposed Action

DOE's Proposed Action is to provide federal funding to support the design, construction, and startup of the biorefinery. The biorefinery would use biomass (for example, corn stover, milo stubble, wheat straw, and switchgrass) as feedstock to produce biofuels, such as ethanol [18 million gallons (68 million liters) per year], for sale to the conventional market and bioenergy (92 megawatts of electricity) to meet the electrical needs of the facility and for sale to the regional power grid. The biorefinery would process 2,500 dry short tons (2,300 dry metric tons) per day of feedstock, which would be obtained from producers within 50 miles (80 kilometers) of the *Biorefinery Project site*. Figure 2-2 presents a simplified diagram of the process that Abengoa Bioenergy would use to convert biomass feedstock to biofuel and biopower. Figure 2-3 is a photograph of a biorefinery in York, Nebraska; the proposed biorefinery would have a similar appearance. Figure 2-4 is a conceptual drawing of the current layout of the biorefinery facilities.

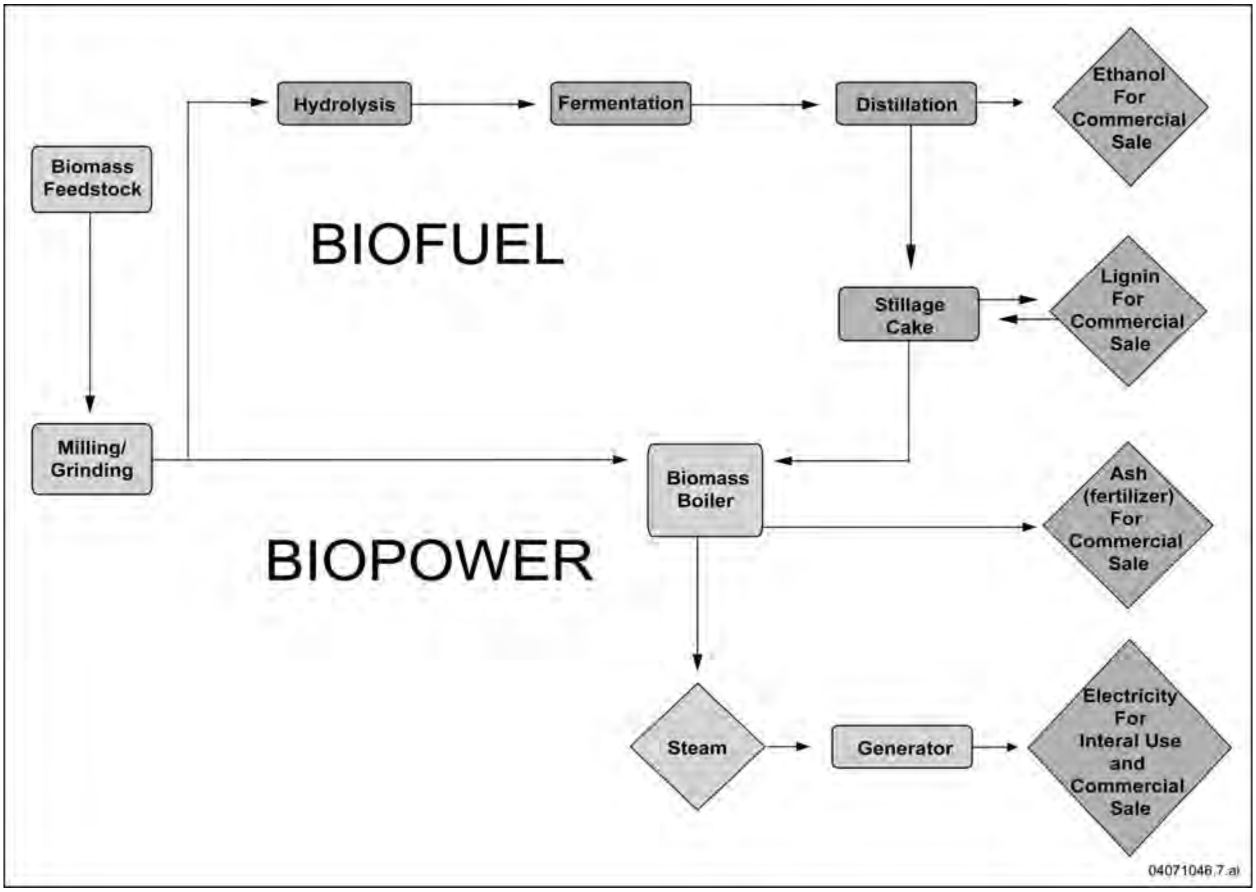

Figure 2-2. Simplified diagram showing conversion of feedstocks to biofuel and biopower under the Proposed Action.

Figure 2-3. Biorefinery in York, Nebraska.

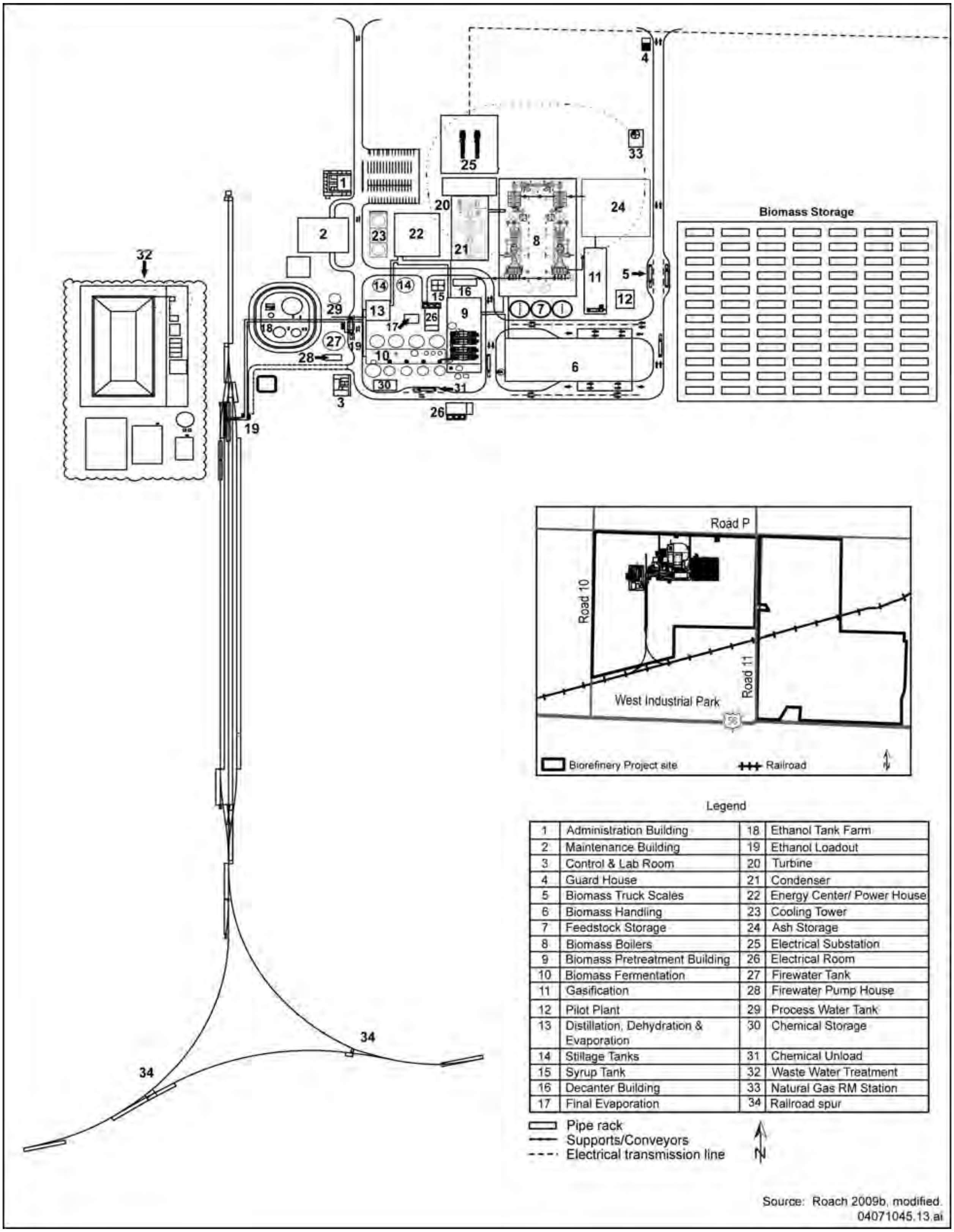

Figure 2-4. Site layout of biorefinery (concept).

2.1.1 CONSTRUCTION

Abengoa Bioenergy would construct the biorefinery on a 385-acre (1.6-square-kilometer) parcel on the west site of the Biorefinery Project site (Chapter 1, Figure 1-2). Abengoa has optioned an additional 425 acres (1.7 square kilometers) immediately east of the *biorefinery parcel*, between the biorefinery and the Hugoton, Kansas, city limits, as a *buffer area*. The optioned parcel would continue to be used as agricultural land and might be used to test production of various feedstocks, such as new varieties of switchgrass. Water from the proposed wastewater treatment facility would be used to irrigate the buffer area. The biorefinery would include commercial, fuel-grade cellulosic ethanol facilities, electricity production facilities, and an onsite 0.5-mile (0.8-kilometer)-long railroad spur for railroad access to receive materials and ship product (Figure 2-4).

Construction of the biorefinery would take approximately 18 months and would include infrastructure improvements, such as construction of site roads that would tie to Rural Road P and a 0.5-mile (0.8-kilometer)-long railroad spur within the Biorefinery Project site that would tie to the Cimarron Valley Railroad as well as installation of new electrical transmission line along County Roads P and 11. Construction activities would include use of heavy diesel-operated equipment, such as trucks, cranes, bulldozers, dumpers, front-loaders, and excavators. Dust control and silt- and erosion-control measures would be implemented for all disturbed areas during the entire construction period. Temporary connections to utilities would include electricity, cable, telephone, and a nonpotable water line. Temporary potable water and sanitary facilities would be provided onsite until construction of permanent, onsite facilities.

Construction activities would start with the removal of vegetation and stripping and stockpiling the topsoil for future use, such as reclamation of areas not covered by permanent structures. Construction crews would grade the site and begin construction of the railway and foundations. Once grading was complete, workers would install underground utilities.

After installation of utilities, permanent roadways would be stabilized and prepared for paving while disturbed but temporary roads and areas would be seeded. Coincident with these activities, crews would install buildings, heavy process equipment, and chemical storage tanks, as shown in Figure 2-5, prior to paving permanent roads. After final grading, paving, and landscaping, all construction silt- and erosion-control measures would be removed from the site. Construction of the facility would be complete when electrical, mechanical, and communications connections were final.

2.1.2 OPERATIONS

The biorefinery would operate 24 hours a day, 350 days a year. Preliminary design and processes are presented in Appendix A of this Abengoa Biorefinery Project EIS. The biorefinery would produce up to 18 million gallons (68 million liters) of denatured ethanol and 92 megawatts of electricity. Seventy megawatts of electricity would be sold commercially. Discussions between Abengoa Bioenergy and the Sunflower Electric Power Corporation concerning the commercial sale of electric power are underway. The following sections describe operations of the biorefinery.

2.1.2.1 Harvesting and Handling Feedstock

The following sections present harvesting and collection, storage, and preparation of feedstock for conversion to biofuels and bioenergy.

2.1.2.1.1 *Harvesting and Collection of Feedstock*

Abengoa Bioenergy would execute contracts with local producers to purchase biomass from locations within 50 miles (80 kilometers) of the Biorefinery Project site. Contracts with biomass producers would reflect resource conservation and agricultural program guidelines to ensure best management practices, such as topsoil protection, are used during harvesting. Initially, the primary feedstock for the biorefinery would be corn stover; other feedstocks would include milo stubble, wheat straw, and switchgrass. Over time, Abengoa would increase the use of switchgrass until it became the primary feedstock. Corn stover, milo stubble, and switchgrass harvesting would begin mid-October and last between 8 and 14 weeks. Wheat straw harvesting would begin mid-June and last approximately 3 weeks. Harvesting of biomass would occur after grain harvesting and would involve use of a windrower to cut stalks; a baler to compress, bale, and bind the bales; bale accumulator to collect the bales; bale squeeze to stack the bales; and flatbed trailers for transport. Bales would be transported to either the biorefinery or *offsite storage locations*. Figure 2-5 shows the kinds of equipment that would be used to harvest and transport the bales of feedstock.

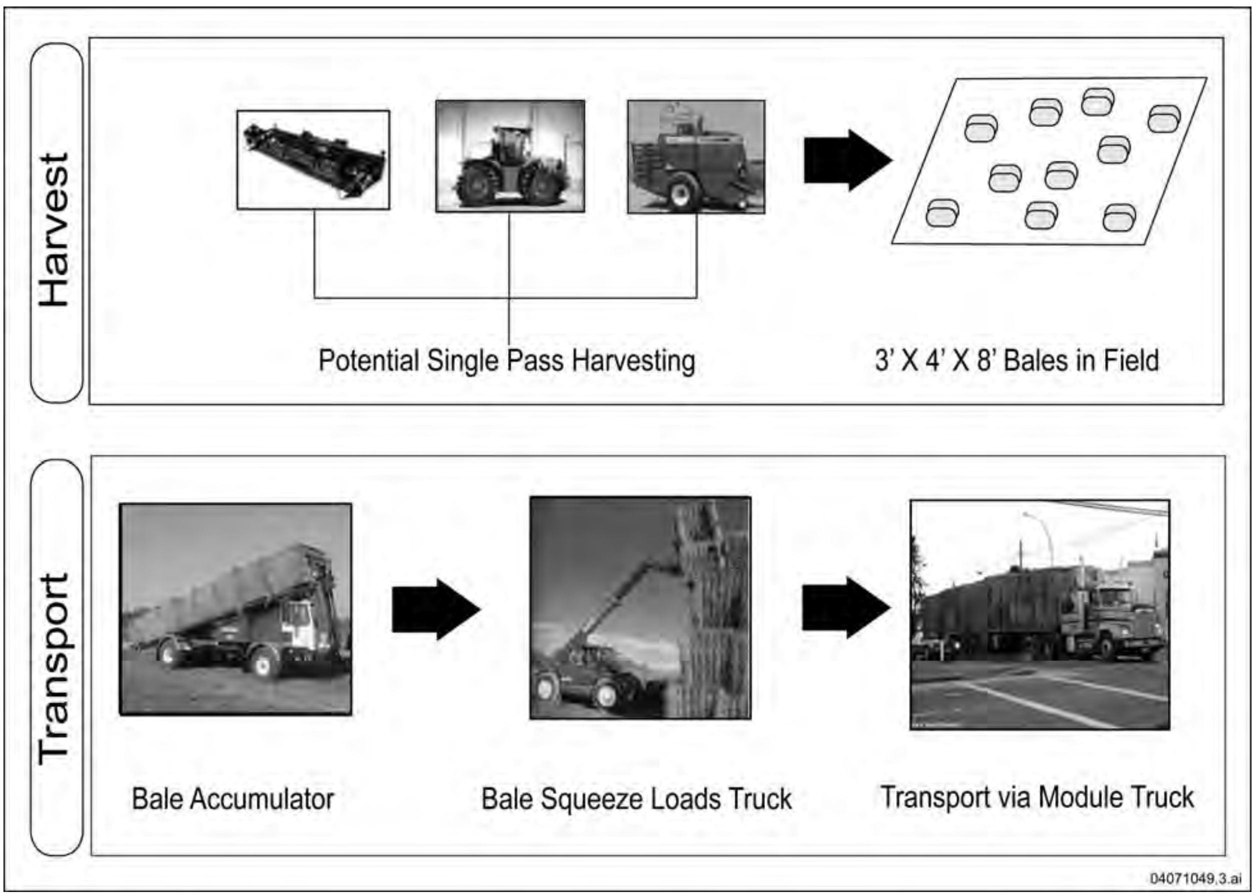

Figure 2-5. Harvesting and transport equipment for biorefinery.

2.1.2.1.2 *Offsite Storage of Biomass Feedstock*

Biomass feedstock would be stored at seven locations within 30 miles (48 kilometers) of the Biorefinery Project site. Although these locations have not yet been identified, they would be areas that:

Do not interfere with crop production or irrigation activities,
Utilize lands that are marginal for crop production, and
Provide truck access.

Each storage location would comprise about 160 acres (0.65 square kilometer) and, together, would accommodate the amount of biomass needed to support biorefinery operations for up to 1 year. At each location, bales would be stacked to accommodate offloading of arriving trucks during the biomass harvesting season and loading of trucks for shipment to the biorefinery. No permanent structures would be needed at these locations to facilitate offloading or loading operations.

2.1.2.1.3 *Onsite Biomass Feedstock Receiving, Grinding, and Storage*

Biomass would primarily be stored offsite. However, Abengoa Bioenergy would store a 2.6-day supply of biomass on 10 acres (0.04 square kilometer) onsite to ensure process continuity in case of a short-term disruption of biomass delivery from offsite locations (due to bad weather, for example).

Handling operations would consist of receiving the biomass bales by truck and unloading them at a bale barn large enough to support a “nearly just in time” operational process. Grinding would be required for both biofuel and bioenergy production. Grinding is a mechanical process that reduces the biomass into useable sizes for feedstock for ethanol production and the biomass boilers. To *attenuate* the *noise* associated with the hammer mills used for grinding, the hammer mills would be housed within the Biomass Handling Building (Figure 2-4, Building 6), where all grinding would take place. Approximately 2,500 dry short tons (2,300 dry metric tons) of biomass a day would be processed for feedstock.

Flatbed trailer-loads of baled biomass would be unloaded via overhead cranes. The cranes would either place the bales in intermediate storage inside the bale barn or onto process in-feed conveyors. Baled biomass would then travel via the conveyer from the bale barn to the grinding lines. Each grinding line would be equipped with a receiving processing unit that grinds and cleans the feedstock. There would be four storage silos (Figure 2-4, Building 7) to store the feedstock that is not sent directly to the process metering bins: one for biomass feedstock supplying the *enzymatic hydrolysis* for ethanol production and three for biomass feedstock supplying the solid biomass boilers.

The biomass receiving, grinding, and storage operations would be an enclosed, high-velocity, positive pressure collection and transfer system to capture and transfer airborne particles to a dirt loadout tank. The loadout tank, grinding activities, and associated transfer points would have fabric filter dust collectors (baghouses).

2.1.2.2 Ethanol Production

This section describes the ethanol production process diagrammed in Figure 2-2. Ethanol would be produced using approximately 670 short tons (610 metric tons) of biomass feedstock a day. The following sections describe the steps/areas, listed below, required for production of ethanol:

enzymatic hydrolysis and fermentation
distillation and dehydration
ethanol denaturant and storage.

The biorefinery would produce up to 18 million gallons of denatured ethanol a year.

2.1.2.2.1 *Enzymatic Hydrolysis and Fermentation*

Once milled, the feedstock would be conveyed to the Biomass Pretreatment Building (Figure 2-4, Building 9).

CONSTITUENTS OF BIOMASS FEEDSTOCK

Cellulose:
An organic compound consisting of a linear chain of several hundred to over ten thousand glucose molecules (polysaccharide). Cellulose is broken down to simple sugars during enzymatic hydrolysis.

Hemicellulose:
Any of several branched polysaccharides present in almost all plant cell walls along with cellulose. Hemicellulose has a random, amorphous structure with little strength. It is easily hydrolyzed by dilute acid or base as well as myriad hemicellulase enzymes. Hemicellulose is broken down to simple sugars during acid pretreatment.

Pectin:
Part of the non-woody parts of terrestrial plants. In the space between plant cells, *pectin* helps to bind cells together. The amount, structure, and chemical composition of the pectin differ between plants, within a plant over time, and in different parts of a plant. Hard parts of a plant contain more pectin than soft parts. Pectin is broken down to simple sugars during acid pretreatment.

Lignin:
A complex chemical compound that is an integral part of the cell wall of plants. Lignin fills the spaces in the cell wall between cellulose, hemicellulose, and pectin components. Lignin is not broken down to simple sugars. Lignin would be recovered from the process as a byproduct or treated as a waste.

The cellulose-rich, lignin-rich feedstock would be treated with enzymes and *genetically modified organisms* (enzymatic hydrolysis) to simultaneously break down the tougher cellulose and ferment the recovered sugars (Figure 2-4, Building 10) resulting in “beer.” At the conclusion of the fermentation process, the beer is between 4 and 5 percent ethanol. Beer would be conveyed to the distiller for purification. *Volatile organic matter* released during processing would be captured in a *vent scrubber*. Liquid from the vent scrubber would be sent to the wastewater treatment facility described later in this chapter.

2.1.2.2.2 *Distillation and Dehydration*

The beers from enzymatic hydrolysis and the fermentation process would be distilled and dehydrated (Figure 2-4, Building 13). Ethanol must be anhydrous (without water) for use as a biofuel. Distillation removes the majority of the water and residual solids from the ethanol. Distillation also destroys all living organisms, including genetically modified organisms.

Soluble and insoluble solids would be recovered from the bottom of the distillation column. The insoluble solids, referred to as *lignin*-rich *stillage cake* would be separated from the soluble solids. The soluble solids would be concentrated to a thin *stillage syrup* in an evaporator and would be combusted in the biomass boilers. Volatile organic compounds released during processing would be captured in a vent scrubber. Liquid from the vent scrubber would be sent to the wastewater treatment facility.

The ethanol production process would produce about 117,000 tons (about 106,000 metric tons) per year of lignin-rich stillage cake. A lignin producer would purchase this lignin-rich stillage cake as crude lignin. The producer would have its processing plant near the biorefinery to reduce transportation costs between the biorefinery and the lignin processing plant. A conveyer would transport the lignin-rich stillage cake the short distance between the biorefinery and the producer's processing plant. After the lignin was extracted, the lignin producer would return the lignin-poor stillage cake and Abengoa Bioenergy would use it as fuel for the solid biomass boiler.

The three main markets for lignin-derived products in North America include resin-based binders and bonding agents, antioxidant agents, and water-soluble derivatives and compounds. The most likely use for the recovered lignin would be as a replacement for phenol used in wood bonding to create such products as plywood and fiberboard. Until the lignin extraction plant is built, Abengoa Bioenergy would burn the lignin-rich stillage cake as solid fuel in the biomass boiler. If lignin extraction is determined not to be commercially viable, lignin-rich stillage cake would be used as solid fuel in the biomass boiler for the life of the biorefinery. Both options for treatment of lignin are discussed in Chapter 4, Section 4.6.

2.1.2.2.3 *Ethanol and Gasoline (Denaturant) Loadout*

The facility design incorporates two shift tanks that would hold the anhydrous ethanol produced during an 8-hour shift (Figure 2-4, Building 18). Each shift tank would have a capacity of 60,000 gallons (230 cubic meters) of ethanol. Ethanol product not meeting required quality control specifications (for example, ethanol containing water) would be stored in a 60,000-gallon tank until transfer back to the distillation, dehydration, and evaporation facility (Figure 2-4, Building 13) for reprocessing.

Gasoline would be added to denature the ethanol to make it unfit for human consumption. A 22,500-gallon (85-cubic-meter) denaturant tank would store gasoline to be used for blending with the ethanol product. The final ethanol product would be approximately 4.9 percent gasoline and would be stored in one 460,000-gallon (1,740-cubic-meter) tank until shipment.

Each tank in the storage area would be built onsite and would have an *internal floating roof* design. Abengoa Bioenergy would provide meters, filters, pumps, and loadout equipment, as required, for loadout into rail tankers. The storage tanks would be enclosed in a bermed area to contain spills that could occur.

Liquid product loadout would involve loading gasoline (denaturant) and denatured ethanol to and from tanker trucks and tanker railcars. The denatured ethanol would ship by rail.

2.1.2.3 Power Generation

Electricity would be produced via the high-pressure, steam-condensing turbine generator (Figure 2-4, Building 20). The gross power produced at the biorefinery would be 92 megawatts. Biomass boilers would be used to produce steam. Steam would be used for ethanol production processes and electricity production.

Figure 2-4 shows the Biomass Boiler Building (Building 8). Approximately 1,900 dry short tons (1,700 dry metric tons) per day of biomass feedstock would supply a solid biomass boiler to produce high-pressure superheated steam for the high-pressure steam-condensing turbine generator. In addition, the biomass boiler would use much of the waste resulting from ethanol production, including particles collected during milling, stillage cake and syrup from the distillation process. The solid biomass boiler would produce almost 80,000 tons (approximately 73,000 metric tons) of ash annually. This ash would contain potassium and phosphorous and would be marketed to local biomass producers as a soil amendment. In the event there is no market for the ash as a fertilizer replacement, the ash would go to landfills. Impacts from both options for the ash are addressed in Chapter 4.

2.1.2.4 Support Facilities and Infrastructure

2.1.2.4.1 *Emergency Equipment*

The facility design incorporates an emergency firewater tank and a separate pump house equipped with two electric pumps and one diesel-powered engine (Figure 2-4, Buildings 27/28). Since the emergency equipment would be diesel-fired, the design includes installation of a diesel storage tank. The facility design also incorporates an emergency power back-up generator equipped with a diesel-powered engine.

2.1.2.4.2 *Chemical Storage Pad*

The chemical storage pad (Figure 2-4, Building 30) would hold a 10,000-gallon (40-cubic-meter) tank for sodium hydroxide (used for pH adjustment), a 13,300-gallon (50-cubic-meter) tank for urea (used for biomass fermentation), a 30,400-gallon (115-cubic-meter) tank for ammonia (used for pH control in the enzymatic hydrolysis process and nitrogen control in the biomass boilers), a 50,400-gallon (191-cubic-meter) tank for sulfuric acid, a 53,600-gallon (203-cubic-meter) tank for hydrolytic enzyme cocktail (*cellulase* and *hemicellulase* that perform the enzymatic hydrolysis of the cellulose and any residual hemicellulose in the pretreated biomass), a 53,000-gallon (201-cubic-meter) tank for corn syrup (used to activate the enzymes for hydrolysis), and a 8,000-cubic-foot (230-cubic-meter) silo for lime storage and storage capacity for 3,000 cubic-foot (85-cubic-meter) storage of limestone (used to neutralize the sulfuric acid). The storage tanks would be enclosed in a bermed area to contain spills that could occur.

2.1.2.4.3 *Wastewater Treatment Facility*

The onsite wastewater treatment facility (Figure 2-4, Building 32) would treat all wastewater generated at the facility and would not discharge any to the Hugoton wastewater treatment system. The biorefinery would produce approximately 250 gallons (950 liters) per minute of wastewater that would be treated onsite and reused in the biorefinery processes. The *aerobic* treatment operation would include a membrane bioreactor. One homogenization basin and one emergency pond are included in the wastewater treatment system design. Treated wastewater would be recycled to the enzymatic hydrolysis process. Abengoa Bioenergy would apply approximately 7.5 to 10 gallons (28.4 to 38 liters) per minute of wastewater treatment facility sludge on the buffer area. The land application of this sludge would require a discharge permit from the Kansas Department of Health and Environment. There would be no discharge of wastewater to surface water.

2.1.2.4.4 *Non-Contact Cooling Tower*

Water circulating through heat exchangers, a chiller, and a cooling tower (Figure 2-4, Building 23) would cool equipment and process material during ethanol production. No water discharged from the processes producing ethanol or generated from the cooling tower would come into contact with the production processes. Non-contact cooling wastewater, including reject water from the reverse osmosis process, softener regeneration water, boiler blowdown water, and cooling-water tower blowdown water (approximately 225 gallons [852 liters] per minute), would not be treated in the onsite wastewater treatment system. Instead, it would be used as irrigation water on the buffer area immediately east of the biorefinery parcel. The land application of non-contact cooling wastewater would require a discharge permit from the Kansas Department of Health and Environment. There would be no direct discharge of wastewater to surface water.

2.1.2.4.5 *Paved Plant Roads*

In-plant haul roads would be paved to reduce air emissions. Process-related materials would be received onsite by truck and would include biomass feedstock, and chemicals and supplies. Process-related materials would be shipped offsite by truck and would include cellulose feedstock cleaning waste, and ash. Abengoa Bioenergy would establish a maximum speed limit of 25 miles (40 kilometers) per hour and develop, maintain, and implement a *fugitive dust* control strategy and monitoring plan to reduce visible emissions.

2.1.2.4.6 *Railroad Spur*

A 0.5-mile (0.8-kilometer)-long railroad spur (Figure 2-4) would be built on the Biorefinery Project site to tie the biorefinery to the Cimarron Valley Railroad to receive materials and ship denatured ethanol. Disturbance during construction of the railroad spur is discussed in Section 2.1.1

2.1.2.4.7 *Transmission Lines*

A new 115,000-volt (115-kilovolt) transmission line would be constructed. The approximately 1.5 mile (2.4-kilometer)-long line would begin at the Pioneer Electric Cooperative, Inc., Hugoton Substation, which is approximately 1 mile (1.6 kilometers) northwest of the Hugoton, Kansas, city limits, and run south along County Road 11 and west along County Road P from the Hugoton Substation to the biorefinery. The location of the transmission line as it would enter the biorefinery substation is shown on Figure 2-4. The transmission line is envisioned to be single-pole design (wood), with three-phase conductors (one per phase) and one steel overhead shield wire.

There would be minimal land disturbance associated with the new transmission line and the expansion at the Hugoton Substation. The permanent disturbance would be the land directly impacted by the placement of poles into the ground. It is anticipated that the poles would be embedded into the ground to a depth from 12 to 15 feet (3.7 to 4.6 meters) with the excavated soil spread aboveground at each pole site. Each pole would be from 2 to 3 feet (0.61 to 0.91 meters) in diameter and 80 feet (24 meters) high. Single-pole transmission lines usually have from 8 to 12 poles per mile. The other land disturbances associated with the transmission line would be those associated with construction and placement of the poles and the movement of equipment from pole location to pole location. A 60-foot-wide (18.3-meter-wide) easement (30 feet [9.1 meters] per side) is required along the power line route. All routing turns would likely need guy wires extending down from poles to the ground at a 30-degree angle.

2.1.2.4.8 *Water Supply*

The biorefinery processes would require water for consumptive uses including direct process water and non-contact cooling water. The water balance for the biorefinery estimates a continuous demand of 1,370 gallons (5,200 liters) per minute of well water (normal demand) averaged over time. Abengoa Bioenergy has optioned to purchase existing irrigation water rights from eight agricultural water supply wells. Water use would be converted from agricultural to industrial use to satisfy the water demand of the biorefinery. Approval would be required by the Kansas Division of Water Resources to change the use from irrigation to industrial purposes.

2.1.3 DECOMMISSIONING AND DESTRUCTION OF THE BIOREFINERY

For the purposes of the analysis in this EIS, the projected life of the biorefinery is 30 years. However, Abengoa Bioenergy has not projected a life for the facility. The bioenergy industry is so new that no bioenergy facilities have been decommissioned. While there are no data on which to base the impacts associated with decommissioning and destruction of the biorefinery, DOE does not anticipate impacts to be greater than the impacts associated with construction of the facilities.

2.2 Action Alternative

For the Action Alternative, DOE would provide federal funding to support the design, construction, and startup of a biorefinery that would use a two-stage process to pretreat and hydrolyze and ferment sugars for bioethanol production and would produce syngas using a gasification system.

SYNGAS

Syngas, a biofuel, is a mixture of carbon monoxide, hydrogen, methane, carbon dioxide, and higher hydrocarbon gases. Syngas results from heating biomass in the presence of about one-third the oxygen necessary for complete combustion. Syngas has been used successfully in natural gas-based, reciprocating internal combustion engines and gas turbines with only small modifications.

A boiler fueled with syngas, as well as a biomass boiler, would produce steam. Steam from both boilers would be used to produce ethanol and electricity. The boilers and associated turbines, which would be smaller than those under the Proposed Action, would generate electricity sufficient to operate the biorefinery only.

The milling process under the Proposed Action and Action Alternative is the same. Once milled, the feedstock would be conveyed to the Biomass Pretreatment Building (Figure 2-4, Building 9) for removal of the hemicellulose and pectin with dilute acid. The pretreatment process disrupts the hemicellulose/lignin sheath that surrounds the cellulose in plant material. The hemicellulose and pectin would be recovered as simple sugars and separated from the water-insoluble, cellulose-rich, lignin-rich fiber. Before fermentation, the simple sugars recovered during pretreatment would be treated with lime to neutralize the acid.

After pretreatment, the cellulose-rich, lignin-rich fiber would be treated with enzymes and genetically modified organisms (enzymatic hydrolysis) to simultaneously break down the tougher cellulose and ferment the recovered sugars (Figure 2-4, Building 10) resulting in beer. Volatile organic matter released during processing would be captured in a vent scrubber.

The simple sugars recovered after pretreatment would be transferred to the fermentation tanks via conveyer and mixed with genetically modified organisms to ferment (Figure 2-4, Building 10). At the conclusion of the fermentation process, the beer is between 4 and 5 percent ethanol. Beer would be conveyed to the distiller for purification. Volatile organic matter released during processing would be captured in a vent scrubber.

The beers from enzymatic hydrolysis and the fermentation process would be combined, distilled, and dehydrated (Figure 2-4, Building 13). Ethanol must be anhydrous (without water) for use as a biofuel. Distillation removes the majority of the water and residual solids from the ethanol. Distillation also destroys all living organisms, including genetically modified organisms.

Approximately 71,000 dry short tons (64,000 dry metric tons) per year of soluble and insoluble solids would be recovered from the bottom of the distillation column. The insoluble solids, referred to as lignin-rich stillage cake would be separated from the soluble solids. The soluble solids would be concentrated to a thin stillage syrup in an evaporator and would be combusted in the biomass boilers. Volatile organic matter released during processing would be captured in a vent scrubber.

The ethanol production process would produce approximately 130 dry short tons (120 dry metric tons) per day of lignin-rich stillage cake. A lignin producer would purchase this lignin-rich stillage cake as crude lignin. The producer would have its processing plant near the biorefinery. A conveyer would transport the lignin-rich stillage cake the short distance between the biorefinery and the producer's processing facility. After the lignin was extracted, the lignin producer would return the lignin-poor stillage cake and Abengoa Bioenergy would use it as fuel for the solid biomass boiler. If recovery of lignin is not economically feasible, lignin-rich stillage cake would be used as fuel in the biomass boiler.

The three main markets for lignin-derived products in North America include resin-based binders and bonding agents, antioxidant agents, and water-soluble derivatives and compounds. The most likely use for the recovered lignin would be as a replacement for phenol used in wood bonding to create such products as plywood and fiberboard. Until the lignin extraction facility is built, Abengoa Bioenergy would burn the lignin-rich stillage cake as solid fuel in the biomass boiler. Denaturing the ethanol produced and load-out are the same under both action alternatives.

Under the Action Alternative, the facility would be used to produce approximately 12 million gallons (45 million liters) per year of denatured ethanol and 19,000 tons (17,000 metric tons) per year of lignin. Syngas produced in the gasification plant under the Action Alternative would operate a fire-tube boiler to produce steam. A small biomass solids boiler would also produce steam to power the biorefinery process operations only. Steam would be used to operate a small turbine that would produce 20 megawatts of electricity. The remaining electrical power needs would be purchased from the grid. Figure 2-6 shows a simplified flow diagram showing the conversion of feedstocks to biofuel and biopower under the Action Alternative.

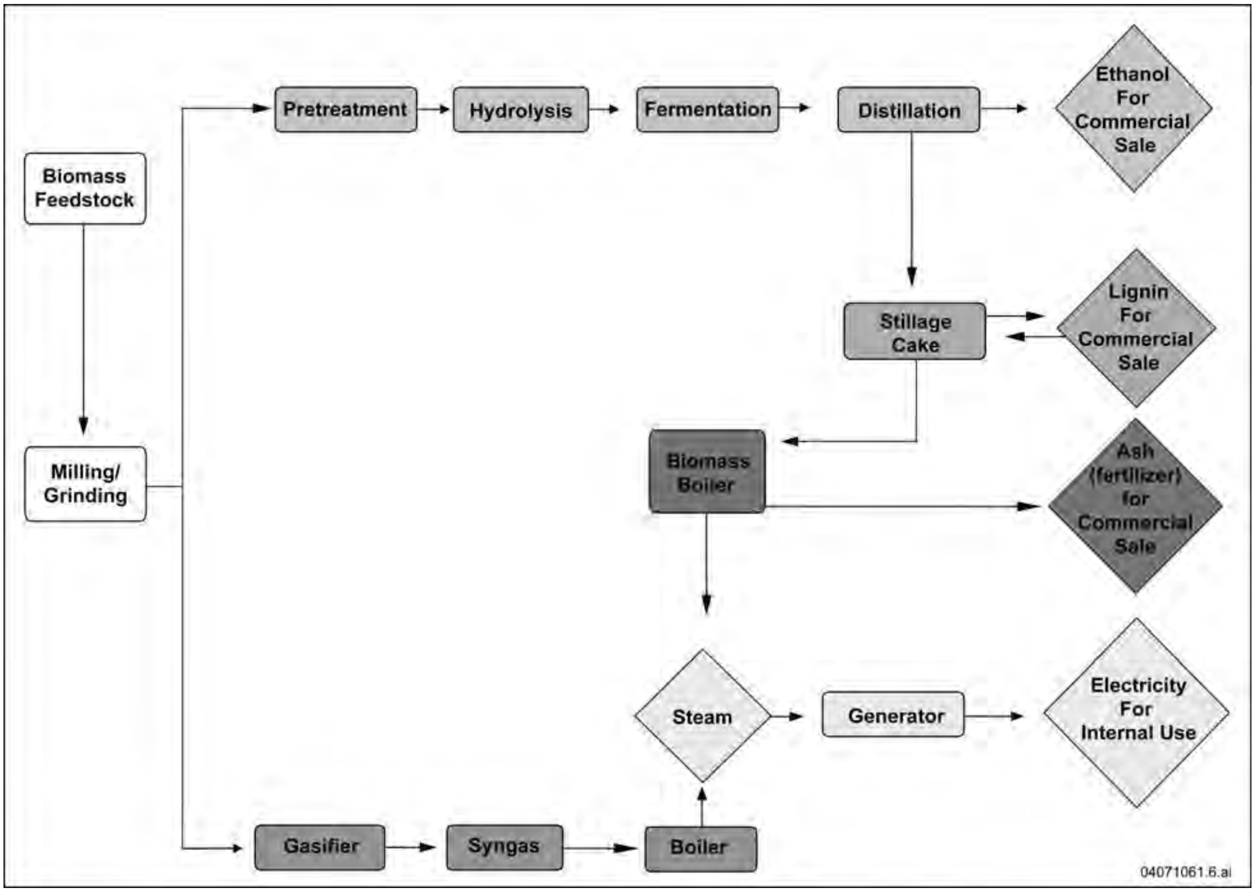

Figure 2-6. Simplified diagram showing conversion of feedstocks to biofuel and biopower under the Action Alternative.

2.3 Comparison of Design Features

Table 2-1 provides a comparative overview of the biorefinery design features and products under the Proposed Action and Action Alternative.

Table 2-1. Comparison of the design features and products of the biorefinery under the Proposed Action and Action Alternative.

Design features/products	Proposed Action	Action Alternative
Biomass feedstock	Approximately 2,500 dry short tons (2,300 dry metric tons) per day	800 dry short tons (700 dry metric tons) per day
Fermentation facility	One step feedstock hydrolysis/fermentation process	Feedstock pretreatment to remove simple sugar molecules followed by hydrolysis/fermentation process on the remaining cellulose
Gasifier	No	Yes, syngas production
Steam production	Larger biomass boiler	Smaller gas boiler and small biomass boiler
Ethanol production	18 million gallons (68 million liters) per year	12 million gallons (45 million liters) per year

Table 2-1. Comparison of the design features and products of the biorefinery under the Proposed Action and Action Alternative (continued).

Design features/products	Proposed Action	Action Alternative
Lignin-rich stillage cake (not including distiller's syrup)	117,000 dry short tons (106,000 dry metric tons) per year	45,000 dry short tons (41,000 dry metric tons) per year
Lignin production	45,000 dry short tons (41,000 dry metric tons) per year	19,000 dry short tons (17,000 dry metric tons) per year
Electricity production	92 megawatts	20 megawatts
Electricity purchase	None	10 megawatts (15 megawatts during peak demand)
Boiler ash	80,000 tons (72,000 metric tons) per year	11,000 tons (10,000 metric tons) per year
Gasifier ash	0	9,000 tons (8,000 metric tons) per year

2.4 No-Action Alternative

Under the No-Action Alternative, DOE would not provide federal funding to Abengoa Bioenergy to support the design, construction, and startup of a biorefinery. Abengoa would not build a biorefinery and the biorefinery parcel would remain agricultural land. The Department recognizes, however, that Abengoa could pursue alternative sources of capital for development of the biorefinery.

2.5 Findings of this EIS

To meet the mandates of the *Energy Policy Act of 2005* and other governing policies, it is in the best interest of DOE to select and fund the most technologically and economically viable alternative. The Proposed Action represents this alternative. DOE has identified the Proposed Action as its preferred alternative.

Table 2-2 summarizes the potential impacts of the Proposed Action, the Action Alternative, and the No-Action Alternative. DOE assessed potential impacts during construction and operation of the proposed biorefinery for 13 resource and subject areas including transportation and accidents. For most resource and subject areas, potential impacts would be small. Potential health and safety impacts indicate the biorefinery could be constructed and operated without significant impacts to workers or the public.

Table 2-2. Comparison of potential impacts under the Proposed Action, Action Alternative, and No-Action Alternative.

Resource area	Proposed Action	Action Alternative	No-Action Alternative
Land use			
	Conversion of 385 acres to non-agricultural production.	Same as Proposed Action.	Land use for the 385 acres (1.6 square kilometers) would remain agricultural.
	No change to land use or agricultural practices to meet demand for biomass feedstock.		
	No changes to land in Conservation Reserve Program, *prime farmland*, *highly erodible* land, or public lands.		
	No change in soil erosion.		
	Minor adverse impact on soil organic content in some fields. No regional impact on agricultural production.		
	Biorefinery consistent with local zoning and land use.		
Air quality			
	Short-term and intermittent emissions during construction.	Same as Proposed Action.	There would be no construction.
	Concentration from operations, along with background concentrations, are about 60% of the *National Ambient Air Quality Standards* for 24-hour PM_{10}, 18% for nitrogen dioxide, and less than 10% of the standards for other pollutants.	Concentration from operations, along with background concentrations, are about 50% of the National Ambient Air Quality Standard for 24-hour PM_{10}, 13% for nitrogen dioxide, and less than 10% of standards for other pollutants.	There would be no changes in air emissions from current background levels.
	Emissions of nitrogen oxide (0.14 pound per million British thermal units) exceed limits specified in EPAct of 2005 (0.08 pound per million British thermal units).		
	Estimated reduction in *greenhouse gas* emissions of 306% by replacing gasoline fuel in vehicles with biomass-derived ethanol.	Estimated reduction in greenhouse gas emissions of 39% by replacing gasoline fuel in vehicles with biomass-derived ethanol.	There would be no reduction in greenhouse gas emissions.
Surface water			
	Minor changes to drainage patterns on the Biorefinery Project site.	Same as Proposed Action.	There would be no changes in drainage patterns on the Biorefinery Project site.

Table 2-2. Comparison of potential impacts under the Proposed Action, Action Alternative, and No-Action Alternative (continued).

Resource area	Proposed Action	Action Alternative	No-Action Alternative
	Runoff and planned releases of wastewater limited to the Project site. No surface waters would be affected by accidental spills. No *floodplain*s or *wetlands* would be affected.		
Groundwater			
	Water Requirements: • Construction phase – 220 acre feet • Operations phase – 2,170 acre-feet annually Net operations water demand is 5,000 acre-feet per year less than permitted for eight supply wells, thus there would be a beneficial decrease in water withdrawals from the High Plains *aquifer*.	Water Requirements: • Construction phase – 210 acre feet • Operations phase – 850 acre-feet annually Net operations water demand is 1,300 acre-feet per year less than permitted for three supply wells, thus there would be a beneficial decrease in water withdrawals from the High Plains aquifer.	Water withdrawal from the affected wells would continue to be used for crop irrigation. There would be no net reduction in water withdrawal from the High Plains aquifer (i.e., 5,000 acre-feet from the Proposed Action or 1,300 acre-feet from the Action Alternative).
Biological resources			
	Minor short-term and long-term impacts to common species from construction and operations within 0.5 mile (0.8 kilometer) of the biorefinery. No *threatened* or *endangered species* would be impacted by the construction and operation of the biorefinery.	Same as Proposed Action	No impacts to biological resources.
Utilities, energy, and materials			
	Maximum domestic and potable water demand about 25% of unused capacity of Hugoton water system. Design capacity of Hugoton sewage lagoons approached during construction, but not exceeded.	Same as Proposed Action	There would be no impact on the Hugoton water system. There would be no increase in the sewage load (beyond current loads) to the Hugoton sewage lagoons.

Table 2-2. Comparison of potential impacts under the Proposed Action, Action Alternative, and No-Action Alternative (continued).

Resource area	Proposed Action	Action Alternative	No-Action Alternative
	Energy: Needs of biorefinery generated onsite, and 70 megawatts of electricity supplied to regional grid (equal to 5.4% of production capacity in western-central Kansas).	Requires electrical power from regional grid, equal to less than 1% of production in local region.	No electrical power would be needed and no electricity would be supplied to the regional grid.
	Construction materials: With possible exception of stainless steel, no availability issues, and needs would not stress regional market for materials.	Same as Proposed Action.	No additional demand (beyond current levels) for construction materials.
Waste, byproducts, and *hazardous materials*			
	Stevens County landfill would not have adequate capacity to receive construction or operations wastes generated and maintain its small arid landfill exempt status. This waste could be split among other landfills and a transfer station in the region.	Same as Proposed Action.	There would be no wastes, byproducts or hazardous materials generated.
	Ash not used as a soil amendment would be disposed of among the landfills and transfer stations in the region.		
	No adverse impacts from land application of wastewater or sludge.		
	No adverse impacts if proposed *hazardous waste* management practices are implemented.		
Transportation			
	32 estimated traffic fatalities from shipments and commuting workers.	13 estimated traffic fatalities from shipments and commuting workers.	There would be no shipments or commuting workers and thus no associated traffic fatalities.
	$680,000 annual cost of pavement damage from biomass shipments.	$210,000 annual cost of pavement damage from biomass shipments.	There would be no shipments or commuting workers and thus no associated pavement damage.
	No adverse impacts to operation of local railroad.	No adverse impacts to operation of local railroad.	
	No roadway improvements required to reduce congestion or improve access to site.	No roadway improvements required to reduce congestion or improve access to site.	

Table 2-2. Comparison of potential impacts under the Proposed Action, Action Alternative, and No-Action Alternative (continued).

Resource area	Proposed Action	Action Alternative	No-Action Alternative
Visual resources			
	Several structures, including a 115-foot-tall structure, visible from surrounding vantage points.	Fewer tall structures than Proposed Action, thus less visible from surrounding vantage points.	No structures would be built on the Biorefinery Project site and visual resources would be unchanged.
	Source of night lighting.	Source of night lighting.	No source of night lighting.
	A 1.5-mile-long transmission line visible from Road P and Road 11.	No new transmission line.	No new transmission line.
Noise			
	Noise exposure to workers would be minimized through implementation of a hearing conservation program.	Same as Proposed Action.	There would be no change in noise from background levels.
	Construction and operations noises would be near background levels at the nearest residences.		
	Nearby residences and a hospital, churches, and other facilities in Hugoton would experience noise from passing trucks about every 9 to 24 minutes, which would interfere with conversations outdoors and cause annoyance indoors.	Trucks would pass residences and facilities in Hugoton every 30 minutes or less, which would interfere with conversations outdoors and cause annoyance indoors.	There would be no trucks passing and thus no interference with conversations outdoors and annoyance indoors.
Odor			
	Odors would not be detectable offsite.	Same as Proposed Action.	There would be no odors.
Socioeconomics			
	Up to 256 workers employed during construction and 43 during operations.	Up to 230 workers employed during construction and 34 during operations.	There would be no increase in employment above current levels.
	1% increase in the population of the region during construction, and 0.1% increase during operations.	0.9% increase in the population of the region during construction, and 0.1% increase during operations.	
	Little impact to public services.	Little impact to public services.	There would be no impact on public services.
	$17 million annual infusion of earnings during construction and $4.4 million annually during operations.	$16 million annual infusion of earnings during construction and $3.4 million annually during operations.	There would be no annual infusion of earnings.

Table 2-2. Comparison of potential impacts under the Proposed Action, Action Alternative, and No-Action Alternative (continued).

Resource area	Proposed Action	Action Alternative	No-Action Alternative
Cultural resources			
	No adverse impacts	Same as Proposed Action.	Same as Proposed Action.
Health and safety			
	Public not affected by industrial hazards.	Same as the Proposed Action.	There would be no hazards to the public.
	Construction workers: 13.5 *total recordable cases*, 7 *days away from work* cases, and 0.026 fatality estimated.	Construction workers: 12.1 total recordable cases, 6.3 days away from work cases, and 0.023 fatality estimated.	
	Operations workers: 2.7 total recordable cases, 0.94 day away from work, and 0.0014 fatality estimated.	Operations workers: 2.3 total recordable cases, 0.68 day away from work, and 0.0011 fatality estimated.	
Accidents			
	Accidents during operation of the biorefinery would be unlikely to impact the general public.	Same as the Proposed Action.	There would be no potential for accidents and thus no hazards to the general public.
Environmental justice			
	No impacts to communities with high percentages of *minority* and *low-income* populations.	Same as Proposed Action.	There would be no environmental justice impacts.
	No unique exposure pathways, sensitivities, or cultural practices that would result in different impacts on minority or low-income populations.		
	Disproportionately high and adverse impacts would be unlikely.		

2.6 Alternatives Considered but Eliminated from Detailed Consideration

2.6.1 ALTERNATIVE LOCATIONS

Abengoa Bioenergy considered a number of locations in Illinois, Iowa, Missouri, Nebraska, Oklahoma, eastern Colorado, and Kansas for the biorefinery. Abengoa Bioenergy used the following site selection criteria:

- Proposed ethanol plant would need to be located adjacent to railroad and/or barge transportation;
- Site should be relatively close (within a 50-mile radius) to large quantities of wheat straw, corn stover, certain varieties of grass, and/or other sources of cellulose;
- Facility will need an adequate long-term water supply;
- A minimum requirement of approximately 400 acres of land would be needed for layout of the biorefinery;
- Potential for adverse meteorological conditions to affect refinery operations;
- Overall potential for efficient and cost effective cellulosic ethanol production potential; and
- Public acceptance of an ethanol plant in its respective community.

Abengoa Bioenergy selected six specific locations for more in-depth analyses. These sites included Imperial, Nebraska; Colwich, Dodge City, Wellington, and Hugoton, Kansas; and Gillman, Illinois.

Abengoa Bioenergy eliminated the Imperial, Nebraska, location because its feedstock was primarily corn stover, negating the design efforts to process multiple feedstocks. Colwich and Wellington, Kansas, both ranked low in corn production and had no large feedlots within a 50-mile (80-kilometer) radius. In its review of Dodge City, Kansas, Abengoa Bioenergy could not identify an adequate long-term water supply. Gilman, Illinois, was eliminated not only because it lacked diversity in biomass feedstock, but it has a rainy season in November, which might interfere with harvesting feedstock. Because of these and other reasons identified during its in-depth review, Abengoa Bioenergy selected Hugoton, Kansas, as its preferred site.

2.6.2 ALTERNATIVE DESIGN

The original application for a cellulosic biorefinery proposed a traditional grain-to-ethanol facility integrated with the biomass facility. Market conditions determined that the grain-to-ethanol facility was not economically viable at this time.

2.6.3 ALTERNATIVE PROCESS ELEMENTS

During the initial review of processes for this EIS, DOE considered wet versus dry storage of the biomass, onsite versus offsite storage, and options for the management of lignin and boiler ash. Initial analysis of wet versus dry storage and onsite versus offsite storage did not identify any meaningful environmental differences. DOE retained the management of lignin and boiler ash for detailed analysis.

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Roach, C. 2009b. “Data Need 42.” Email from C. Roach, Abengoa Bioenergy, to E. Harr, S. Walker, R. Tedlock, D. Lechel, and J. Stover, EIS Team, dated March 1, 2009.

Chapter 3

Affected Environment

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3. AFFECTED ENVIRONMENT

To analyze potential environmental impacts that could result from the implementation of the *Proposed Action*, the U.S. Department of Energy (DOE or the Department) has compiled information about the environment that the Proposed Action could affect. The Department used this information to establish the baseline against which it measured potential impacts (Chapter 4). Chapter 3 describes environmental conditions that currently exist at and in the region of influence defined by the construction and operations of the proposed *biorefinery*.

Terms in italics are defined in the Glossary of this EIS (Chapter 10).

To define the existing environment at and in the region of the *Biorefinery Project site*, DOE has compiled environmental baseline information for 13 resource and subject areas. This chapter and supporting documents contain baseline information for:

- Land use. Land use practices and general existing land use conditions within the region of the proposed biorefinery (Section 3.1);
- *Air quality* and climate. The quality of the air in the region, the area's climatic conditions (such as temperature and precipitation), and *conformity* with the State of Kansas implementation plan to ensure that federal actions conform to any initiatives established in the applicable state or tribal implementation plan (Section 3.2);
- *Geology* and soils. The geologic characteristics of the region at and below the ground surface, the frequency and severity of seismic activity, mineral and energy resources, and soil types and hazards (Section 3.3);
- *Hydrology*. Surface water and *groundwater* features in the region and the quality of the water (Section 3.4);
- Biological resources. Plants and animals that live in the region and the occurrence of *threatened and endangered species* (Section 3.5);
- Utilities, energy, and materials. The existing water, sewer, and sanitary waste services; amounts of power supplied to the region; the means by which power is supplied; the availability of gasoline, diesel, natural gas, and propane; and the availability of construction materials (Section 3.6);
- Waste and *hazardous materials*. Ongoing *solid* and *hazardous waste* management practices in the region as well as the hazardous materials in the region (Section 3.7);
- Transportation. The current road and rail infrastructure (Section 3.8);
- Aesthetics: visual resources, *noise*, and odor. Current landscape and views, and noise and odor sources common in the region (Section 3.9);
- *Socioeconomics*. The population, economy, and housing in the region (Section 3.10);
- *Cultural resources*. Historic and archaeological resources in the region and the importance of those resources (Section 3.11);
- Health and safety. The types of injuries and illnesses associated with construction and operations of a biorefinery (Section 3.12); and

- *Environmental justice*. The locations of *low-income* and *minority* populations in the region and the income levels among low-income populations (Section 3.13).

DOE evaluated the existing environment in regions of influence for each of the 13 areas. Table 3-1 defines these regions, which are specific to each resource or subject area in which DOE could reasonably expect direct and indirect impacts, if any, related to the Proposed Action and Action Alternative.

Table 3-1. Regions of influence for the biorefinery.

Resource/Subject area	Region of influence
Land use	Area within a 50-mile (80-kilometer) radius from the Biorefinery Project site
Air quality	*Airshed* around Hugoton, Kansas for conformity with the State of Kansas implementation plan. For discussion of greenhouse gas emission (Chapter 4), the region of influence is national air quality
Geology	Area within a 50-mile radius from the Biorefinery Project site
Hydrology	Surface water – area within a 30-mile (48-kilometer) radius from the Biorefinery Project site
	Groundwater – area within a 50-mile radius from the Biorefinery Project site
Biological resources	Area within a 30-mile radius from the Biorefinery Project site
Utilities, energy, and materials	Public and private resources from which the Proposed Action and Action Alternative would draw
Waste and hazardous materials	Permitted solid and hazardous waste disposal and recycling facilities located at distances from the biorefinery project site that would allow economical service to the facility
Transportation	Area varies with activity, with the maximum region of influence being the area within a 50-mile radius from the Biorefinery Project site
Aesthetics	Visual and noise – area within a 1-mile (1.6 kilometer) radius around the perimeter of the Biorefinery Project site
	Odor – distance from the source where odors are detectable
Socioeconomics	Area where most of the project workforce would be expected to reside: Morton, Seward, and Stevens counties, Kansas, and Texas County, Oklahoma
Cultural resources	Area within a 1-mile radius from the perimeter of the Biorefinery Project site
Health and safety	*Industrial health and safety* – actual work locations, both on- and offsite
	Public health and safety – extends beyond the work locations to include those areas where the public might be affected
Environmental justice	Corresponds to the region of influence for each resource area

3.1 Land Use

This section describes the existing land use environment within the region of influence. The region of influence for land use is defined as the *feedstock procurement area*. For the Proposed Action, it is anticipated that *biomass feedstocks* would be harvested from land within a 50-mile (80-kilometer) radius from the Biorefinery Project site (Roach 2009a). In order to describe the *affected environment* relative to the type of potential land use impact, Section 3.1 is organized into three geographic areas.

The Proposed Action includes harvesting biomass from land within 50 miles (80 kilometers) of the Biorefinery Project site and storing on agricultural lands within 30 miles (48 kilometers) of the Project site (Roach 2009a). Section 3.1.1 describes the affected environment relative to potential agricultural and rural land use impacts.

Land use changes are also anticipated to occur in the immediate vicinity of the Biorefinery Project site and in and around the city of Hugoton due to the development of spin-off businesses, expansion of municipal services, and increased housing needs to support the construction and operations of the biorefinery. Section 3.1.2 discusses the affected environment within 1 mile (1.6 kilometers) of the Project site relative to potential development-related land use impacts.

The Proposed Action includes the direct conversion of land use due to the construction of the biorefinery. Section 3.1.3 discusses the affected environment relative to this proposed land use change.

3.1.1 CONDITIONS WITHIN 50 MILES (80 KILOMETERS) OF THE BIOREFINERY PROJECT SITE

A 50-mile (80-kilometer) radius around the Biorefinery Project site encompasses approximately 7,900 square miles (20,000 square kilometers), or 5.0 million acres, and includes 16 counties in four states: Kansas, Oklahoma, Colorado, and Texas. The 50-mile (80-kilometer) radius is not a definitive cutoff point, but rather represents the range from within which Abengoa Bioenergy anticipates the biomass to be harvested.

Considering the size of the region of influence, a detailed description of existing land use conditions is not feasible. Because the precise land segments from which the biomass would be obtained is unknown, descriptions of specific land segments are not possible. Therefore, DOE describes the land use affected environment within 50 miles (80 kilometers) of the Biorefinery Project site using published data. Because crop *residue* is the primary targeted feedstock, cropland is the focus of this section.

Section 3.1.1.1 describes the general nature of the region of influence to provide perspective. The intent is to characterize the general nature and scale of land use within the region of influence. Section 3.1.1.2 presents a quantitative discussion of the affected environment relative to agricultural land use. Section 3.1.1.3 describes the conservation programs within the region of influence. Land use issues relative to infrastructure and natural resources are described in other sections of this EIS.

3.1.1.1 General Nature

The general nature of land use is described by identifying (1) the type and distribution of land use; (2) natural resources such as soil, water, and atmospheric conditions that characterize land use; and (3) typical land use management practices. Because soil is the major resource concern, this section describes soil concerns and associated conservation practices.

DOE identified the general type and distribution of land use within the region of influence using the U.S. Geological Survey (USGS) National Map Seamless Server Web site (USGS 2001). This mapping system depicts the type of land use by the type of land cover. For the region of influence, the type of land cover is predominantly vegetative. As Figure 3-1 shows, cropland is the primary land use within the region of influence. Pasture and hay land is mainly intermixed with cropland in the northern part of the region of influence. Shrub, scrub, *grassland*, and herbaceous land are concentrated along the drainage corridors and in the southern part of the region of influence.

DOE further identified the general nature of land use within the region of influence using the U.S. Department of Agriculture (USDA) Agriculture Handbook 296: *Land Resource Regions and Major Land Resource Areas of the United States, Caribbean, and the Pacific Basin, 2006* (NRCS 2006a). Two major land resource areas comprise most of the region of influence. The southern portion of the region of influence lies mostly within the Southern High Plains, Northern Part. The northern portion of the region of influence lies mostly within the Central High Tableland. Combined, these two areas represent nearly the entire region of influence and comprise the eastern edge of Colorado, the western quarter of Kansas, the Oklahoma panhandle, and the northern edge of the Texas panhandle.

Nearly all of this combined area is in farms or ranches dominated by cash-grain farming and livestock production. Most of the farm products are marketed locally and the grain is shipped by railroad to the terminal elevators and markets to the east (NRCS 2006b). Over 95 percent of this area is privately owned. About two-thirds of the area is cropland, which is used mainly for growing wheat, grain sorghum, and corn. Other common crops include other small grains, alfalfa, forage, and soybeans. About one-third of the area is range or pasture, including the Cimarron National Grassland. Much of this area consists of hilly and steep slopes bordering the drainage ways and supports native grasses and shrubs used for grazing. Only 2 percent of the land is categorized as urban, and 1 percent is categorized as other. Confined animal-feeding operations, primarily beef cattle and swine, are economically important in the area. In some areas, beef cattle graze small grain pastures throughout the winter. Haying commonly provides supplemental feed during the long winters.

The average annual precipitation in this area is 14 to 25 inches (36 to 64 centimeters), fluctuating widely from year to year. Most of the rainfall occurs as high-intensity thunderstorms during the growing season. The moderately low, erratic precipitations are the source of water for dry-farmed crops and for range and pasture. Most of the area yields adequate groundwater for irrigation, domestic, and livestock needs. In some areas, the declining water table and rising energy costs have resulted in conversion from previously irrigated cropland to dry-farmed cropland.

The soils are generally very deep, well drained, and *loamy*. The major soil resource concerns are wind erosion, water erosion, maintenance of the organic matter content and productivity of soils, and soil moisture management. Conservation practices on cropland generally include systems of crop residue management (such as high-residue crops, *no-till*, and *reduced-till*), *cover crops*, windbreaks, vegetative wind barriers, wind and contour *strip cropping*, terraces, *contour farming*, conservation *crop rotations*, irrigation water management, and pest and nutrient management.

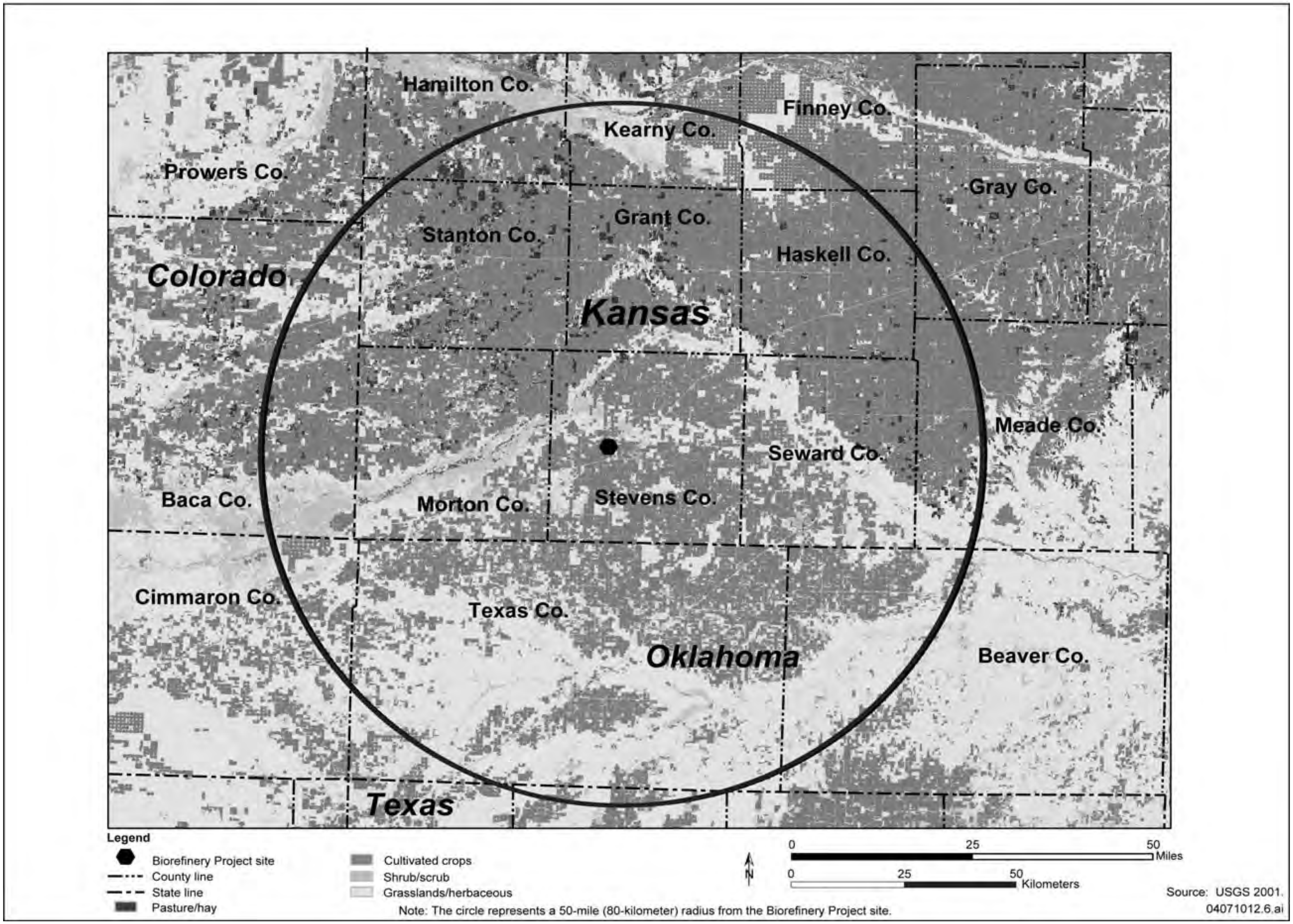

Figure 3-1. Land cover within the region of influence.

Federal lands in the region of influence include the Cimarron National Grassland, which is located in Morton County, Kansas, and the Optima National Wildlife Refuge in Texas County, Oklahoma. State parks in the region of influence include Meade State Park in Meade County, Kansas, which is located at the east edge of the region of influence; Lake Schultz State Park in Texas County, Oklahoma; and Pioneer State Park in Beaver County, Oklahoma.

3.1.1.2 Agricultural Land Use

This section quantifies agricultural land use within the region of influence relative to the anticipated *feedstocks*. Abengoa Bioenergy anticipates that biomass feedstock would consist of 82-percent irrigated corn stover, 7-percent irrigated wheat straw, 7-percent milo stubble, and 4-percent from switchgrass and/or *Conservation Reserve Program* (CRP) land cover (Roach 2009a).

To quantify land use within the region of influence, DOE reviewed the USDA National Agricultural Statistics Service *2007 Census of Agriculture* (NASS 2007). The 2007 census is the most recent census available. DOE used data from the seven counties that are mostly within the region of influence (that is, Morton, Stanton, Grant, Haskell, Seward, and Stevens counties in Kansas and Texas County in Oklahoma). These counties comprise over 3.8 million acres (15,000 square kilometers), which equates to approximately 75 percent of the region of influence. The remaining area within the region of influence lies within nine different counties. This method assumes that on a regional basis, data from approximately 75 percent of the region of influence represent the entire region of influence. Percentage evaluations based on this subset of data do not change when extrapolated to represent the entire region of influence. This method is appropriate for characterizing the general nature and scale of land use within the region of influence. Based on review of the referenced information, DOE observes the following:

- Approximately 97 percent of the land is in farms;
- *Total cropland* accounts for 70 percent of the land;
- *Harvested cropland* accounts for 41 percent of the land;
- Approximately 21 percent of the land is irrigated;
- Fifteen percent is enrolled in conservation programs (see Section 3.1.1.3 for program descriptions);
- Harvested corn, sorghum, and wheat for grain represent 14, 7, and 18 percent of the land use, respectively;
- Corn, sorghum, and wheat for grain combined account for 39 percent of all land use and 94 percent of harvested cropland;
- Approximately 84 percent of corn for grain is irrigated, compared with 20 percent of grain sorghum and 32 percent of wheat; and
- Irrigated corn, sorghum, and wheat for grain account for 88 percent of all irrigated land.

3.1.1.2.1 *Crop Production*

The preceding observations were based on 2007 data. To account for annual variability, DOE reviewed specific crop production information from the USDA National Agricultural Statistics Service's Quick Stats Web site (NASS 2009). While Quick Stats does not include all the information available in the census data, it is the best source of annual county-level data from the National Agricultural Statistics Service. DOE reviewed corn, sorghum, and wheat grain production and crop acreage from 2003 to 2007 for the seven-county area and observed the following:

- The 5-year average annual production of corn, grain sorghum, and wheat for the seven counties is approximately 80, 13, and 28 million bushels (2.0, 0.33, and 0.76 million metric tons), respectively;
- Using these data, the 5-year average annual production over the entire region of influence is estimated to be 106, 17, and 36 million bushels (2.7, 0.43, and 0.98 million metric tons) of corn, grain sorghum, and wheat respectively;
- From 2006 to 2007, corn, grain sorghum, and wheat production increased by 44, 46, and 155 percent, respectively;
- The 5-year average yield of corn, grain sorghum, and wheat is approximately 174, 55, and 38 bushels per acre (1,100, 350, and 260 metric tons per square kilometer), respectively;
- The seven-county, 5-year average of crop acreage for corn, grain sorghum, and wheat is approximately 450,000, 240,000, and 720,000 acres (1,800, 970, and 2,900 square kilometers), respectively;
- Using these data, the 5-year average crop acreage over the entire region of influence is estimated to be 590,000, 320,000, and 950,000 acres (2,400, 1,300, and 3,800 square kilometers) of corn, grain sorghum, and wheat respectively.
- From 2006 to 2007, corn, grain sorghum, and wheat acreage increased by 25, 12, and 30 percent, respectively.
- The 5-year average combined corn, grain sorghum, and wheat crop acreage is approximately 1.9 million acres (7,700 square kilometers).

3.1.1.2.2 *Crop Residue*

Crop residues consist of the biomass that remains in the field after grain harvest. Crop residues are generally left in the field, baled and removed, grazed, or burned. When left in the field, residues perform many positive functions for agricultural soils; the effect is a complex interaction between soil type, topography, climate, and management. Crop residues generally reduce soil erosion; conserve soil moisture; and improve soil structure, organic matter content, and soil microbial communities. These attributes improve soil productivity and long-term soil tilth, and influence the ability of the soil to provide environmental services, such as adsorbing and assimilating mobile nutrients and *sequestering* carbon (BRDB 2008).

In some instances, residue has negative impacts. When left on the surface, residues reduce soil temperature and evaporation, and can impact physical operations. In the spring, lower soil temperatures and wet fields can delay planting. High residue levels can interfere with planting equipment and result in undesirable seed placement and poor seed-to-soil contact. Once seeds are planted, lower soil temperatures can result in poor germination. High residue levels can impede plant emergence and pesticide effectiveness. Some disease-producing organisms benefit from residue removal, while others by residue retention. Residues ultimately recycle nutrients, but additional nitrogen fertilizer is sometimes needed after high residue crops to compensate for increased microbial activity.

Crop residue management is dependent upon the objective and can change from season to season. The particular tillage system chosen has the most dramatic effect on crop residue. Three basic tillage systems are no-till, *conservation tillage*, and conventional tillage. With no-till, generally the only soil disturbance occurs during planting, and weed control is accomplished with herbicides. Mulching or shredding of the residue may be included in no-till systems. Conservation tillage refers to a variety of tillage systems that balance profitable crop production while minimizing erosion. Conventional tillage generally refers to intensive and aggressive soil disturbance that leaves a seedbed with essentially no plant residue on the surface (MWPS 2000).

3.1.1.3 USDA Farm Service Agency Conservation Programs

Land enrolled in the USDA Conservation Reserve, Wetlands Reserve, Farmable Wetlands, and Conservation Reserve Enhancement programs account for approximately 15 percent of the land within the region of influence.

The CRP provides technical and financial assistance to eligible farmers and ranchers to address soil, water, and related natural resource concerns on their lands in an environmentally beneficial and cost-effective manner. The voluntary program encourages farmers to convert *highly erodible* land or other environmentally sensitive acreage to vegetative cover. The CRP is the country's largest private-lands environmental improvement program. The Farmable Wetlands Program is a voluntary program to restore farmable *wetlands* and associated buffers by improving the land's hydrology and vegetation. Eligible producers can enroll eligible land in the Farmable Wetlands Program through the CRP. The Conservation Reserve Enhancement Program is a voluntary land retirement program that helps agricultural producers protect environmentally sensitive land, decrease erosion, restore wildlife habitat, and safeguard ground and surface water. The program is an offshoot of the CRP.

The *Wetland Reserve Program* is a voluntary program offering landowners the opportunity to protect, restore, and enhance wetlands on their property. The USDA Natural Resources Conservation Service (NRCS) provides technical and financial support to help landowners with their wetland restoration efforts. Land enrolled in these programs is considered *out of production*.

In addition to those described above, other USDA conservation programs, such as the Conservation Security Program, Environmental Quality Incentives Program, and Wildlife Habitat Incentives Program, are available to landowners. The Conservation Security Program is a voluntary program that provides financial assistance to promote the conservation and improvement of soil, water, air, energy, plant and animal life, and other conservation purposes on working lands. The Environmental Quality Incentives Program is a voluntary conservation program for farmers and ranchers that promotes agricultural production and environmental quality as compatible national goals. This program offers financial and technical help to assist participants install or implement structural and management practices on working agricultural land. The Wildlife Habitat Incentives Program is a voluntary program for landowners who want to develop and improve wildlife habitat on agricultural land, non-industrial private land, and American Indian land.

CRP land is frequently discussed in analyses of the impacts of biofuel production on land use. CRP land can be impacted in two ways: (1) increased demand for cropland (including energy crops such as switchgrass) could prompt conversion of CRP land to cropland, and (2) the vegetative cover on CRP land could be harvested as a *cellulosic feedstock*. Potential impacts to conservation programs in the region of influence are discussed in Section 4.1.1.1 of this EIS.

In addition to conservation programs, the USDA defines and oversees policies regarding prime farmland and highly erodible land. Section 3.3 describes prime farmland and highly erodible land within the region of influence.

3.1.2 CONDITIONS WITHIN 1 MILE (1.6 KILOMETERS) OF THE BIOREFINERY PROJECT SITE

Land use changes could occur in the immediate vicinity of the Biorefinery Project site and in and around the city of Hugoton due to resultant development. Conditions within 1 mile (1.6 kilometers) of the Project site are described relative to potential development-related land use changes.

3.1.2.1 Zoning

Figure 3-2 shows the city of Hugoton and the surrounding rural area under city jurisdiction. As stated in City of Hugoton Article 2 - Zoning Ordinance, the A-L Agricultural District "is intended to provide a location for land situated on the fringe of the urban area to be used for agricultural purposes, but which will be undergoing urbanization in the foreseeable future. Therefore, the agricultural uses and activities should not be detrimental to urban land uses. It is not intended that this district provide a location for a lower standard of residential, commercial, or industrial development than is authorized in other districts. The types of uses, and intensity of use of land authorized in this district is designed to encourage and protect agricultural uses until urbanization is warranted and the appropriate changes in district classification are made."

The I-2 Heavy Industrial District "is intended for the purpose of allowing basic or primary industries which are generally not compatible with residential and/or commercial activity. Certain extremely obnoxious or hazardous uses will require special permission to locate in this district."

As shown in Figure 1-2 in Chapter 1 of this EIS, Hugoton is east of the Biorefinery Project site. Land west of the Project site and north of the 425-acre (1.7-square-kilometer) *buffer area* is zoned A-L. Land north of the 385-acre (1.6-square-kilometer) *biorefinery parcel* is under county jurisdiction. Land adjacent to the south of the Project site is zoned I-2 and A-L.

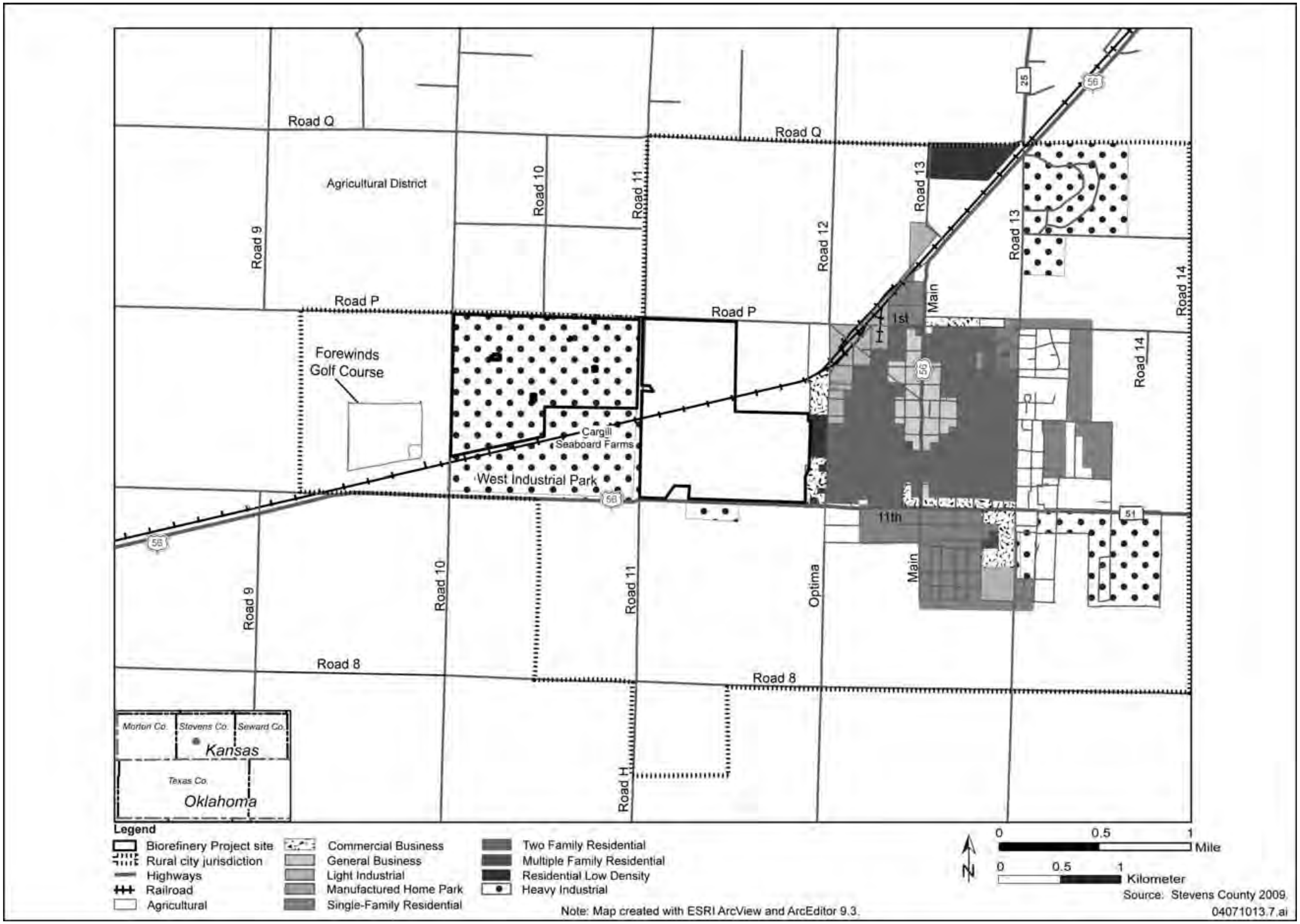

Figure 3-2. Zoning for Hugoton and surrounding area.

3.1.2.2 Land Use

As shown in Chapter 1, Figure 1-2, land use adjacent to the Biorefinery Project site includes cropland to the north; cropland and the city of Hugoton to the east; rangeland and a golf course to the west; and cropland, an industrial park, and an airport to the south. Rural residences are located to the south and the northwest of the Project site. A railroad runs from near the southwest corner of the Project site to near the northeast corner of the buffer area. U.S. Highway 56 (US-56) is south of the site and county roads border the north and west. A county road separates the biorefinery parcel from the buffer area. The remainder of the land use within 1 mile (1.6 kilometers) of the site is agricultural in nature. Most of the land is irrigated cropland, with *dryland cropland* and rangeland as secondary land uses.

DOE reviewed the Kansas Department of Transportation, Stevens County General Highway Map to further identify land use conditions. *Bituminous* roads border Section 17 (buffer area) on all four sides. Stores or small business establishments; a church; dwellings; hotels or motels; abandoned stores or small business establishments; and a scenic, tourist, or historical site are on the east side of Section 17. A gravel road borders Section 18 (biorefinery parcel) on the west and bituminous roads border the sections on the north, south, and east. Two grain elevators are also on the eastern portion of Section 18 (KDOT 1997).

The West Industrial Park, located south of the Biorefinery Project site, is zoned I-2 Heavy Industrial District. Table 3-2 summarizes information about businesses within the West Industrial Park. This information was compiled and provided by Stevens County Economic Development (Gillespie 2007). Some of the lots are undeveloped and the planned use is unknown.

Table 3-2. Businesses in the West Industrial Park.

Block	Lot(s)	Owner	Use
1	1,2,3	Stevens County	Undeveloped
1	4	Sunrise Oilfield Supply	Oilfield supply company
1	5, N6	Cropland Co-Op	Fertilizer and chemical storage for agricultural use
1	S6		Window Wizards (glass company) and Doin' It Right (fencing company)
2	N1		KYNCO, LLC (roustabout service)
2	S1	AB&J, LLC	Buildings used for storage by former large farmer
2	2		BCI Manufacturing (builds spa dollies, mobile advertising trailers, gas compressors, and metal buildings) and Southwestern Gas Compressors
2	3		Triple C Trucking and Kugler Co. (agricultural fertilizer and chemical business)
2	4	Stevens County	Undeveloped
2	5		Heating and air conditioning business
3	1, 2, W3	Stevens County	Asphalt plant
3	E3		Sunrise Oilfield Supply, Inc.
3	4, 5		Undeveloped
3	6	Mid America Cattle Co.	
4	1		Hugoton Welding
4	2, 3	Hammer Construction	Vacant

Table 3-2. Businesses in the West Industrial Park (continued).

Block	Lot(s)	Owner	Use
4	W4		GLB Meters and GLB Services (services and sells water meters and consults about water rights).
4	E4	Grower Solutions	Agriculture fertilizer and chemical sales
4	W5		Abengoa Bioenergy
4	E5		G&G Construction (roofing)
4	W6		Trilobite (oil and gas field services)
4	E6	SV CO	Vacant due to airport flight path requirements

Source: Gillespie 2007.

3.1.3 SITE OF THE BIOREFINERY

The Proposed Action includes the direct conversion of land use type due to the construction of the biorefinery. This section describes conditions on the Biorefinery Project site relative to this proposed land use change.

The Biorefinery Project site is adjacent to and west of the city of Hugoton, in Stevens County, Kansas (Chapter 1, Figure 1-1). The Project site comprises approximately 810 acres (3.3 square kilometers) of row-cropped agricultural land. As shown in Figure 1-2, the biorefinery would be developed on the western 385 acres (1.6 square kilometers) of the Project site, and the remaining 425-acre (1.7-square-kilometer) east parcel would be a buffer area.

3.1.3.1 Zoning

The Biorefinery Project site is outside the Hugoton city limits, but within the rural area under city zoning jurisdiction. According to a zoning map of the city and surrounding area and the City of Hugoton Article 2 - Zoning Ordinance, the biorefinery parcel is conditionally zoned I-2 Heavy Industrial, and the buffer area is currently zoned A-L Agricultural District.

3.1.3.2 Land Use

The biorefinery parcel is used for dryland row-crop farming and grazing. The buffer area contains three center-pivot irrigation systems, and the remaining land is either flood-irrigated or dryland-farmed.

3.2 Air Quality

3.2.1 DESCRIPTION OF EXISTING EMISSION SOURCES

The region of influence for national ambient air quality is the airshed around Hugoton, Kansas, which is located in the southwest corner of Kansas. Activities related to agriculture are anticipated to be the largest contributors of air pollution in this region. Due to the generally rural nature of these activities, and based on available air monitoring data, the region is considered to have relatively low levels of air pollution. The region of influence for greenhouse gas emissions (discussed in Chapter 4, Section 4.2) is the contiguous United States.

The Biorefinery Project site consists of row-cropped agricultural land. A number of emission sources exist in the adjacent areas including grain elevators, the Stevens County Asphalt Plant, Seaboard Farms, and an airport to the south; a golf course and agricultural land to the west; agricultural cropland to the north; and the city of Hugoton to the east. Several rural residences exist within 1 mile of the Project site.

Ambient air quality in a given location may be characterized by comparing the concentration of various pollutants in the ambient air with the standards set by federal and state agencies. In addition, air quality can be characterized by evaluating visual affects. Under the authority of the *Clean Air Act of 1970*, as amended (42 U.S.C. 7401, et seq.), the U.S. Environmental Protection Agency (EPA) has established nationwide air quality standards, known as the *National Ambient Air Quality Standards*. These standards represent the maximum allowable atmospheric concentration of the *criteria pollutants*. There are primary and secondary standards for these pollutants. The primary standards were established to protect the public health within an adequate margin of safety; the secondary standards were established to protect the public welfare from any known or anticipated adverse effects of a pollutant. Under the *Clean Air Act*, state and local agencies may establish their own ambient air quality standards, provided they are as stringent as the federal requirements (40 CFR Part 50).

The airshed around Hugoton is designated by the EPA as an area that is not shown to pose a threat to human health or the environment for which it is termed unclassified (due to limited data) or in *attainment* with the National Ambient Air Quality Standards for sulfur oxides, carbon monoxide, ozone (as volatile organic compounds), nitrogen oxides, and *particulate matter* [including particulate matter with an aerodynamic diameter of 2.5 micrometers or less ($PM_{2.5}$) and particulate matter with an aerodynamic diameter of 10 micrometers or less (PM_{10})]. The State of Kansas has adopted the federal ambient air quality standards, which are presented in Table 3-3.

Table 3-3. National Ambient Air Quality Standards.

Pollutant	Averaging times	Primary standards	Secondary standards
Carbon monoxide	1-hour[a]	35 ppm (40 mg/m^3)	None
	8-hour[a]	9 ppm (10 mg/m^3)	None
Lead	Quarterly average	1.5 μg/m^3	Same as primary
Nitrogen dioxide	Annual (arithmetic mean)	0.053 ppm (100 μg/m^3)	Same as primary
Ozone	8-hour[b]	0.075 ppm	Same as primary
Sulfur dioxide	3-hour[a]	None	0.5 ppm (1300 μg/ m^3)
	24-hour[a]	0.14 ppm (370 μg/m^3)	None
	Annual (arithmetic mean)	0.03 ppm (78 μg/m^3)	None
Particulate matter (PM_{10})	24-hour[d]	150 μg/m^3	Same as primary
	Annual (arithmetic mean)	Revoked[c]	Revoked[c]
Particulate matter ($PM_{2.5}$)	24-hour[f]	35 μg/m^3	Same as primary
	Annual (arithmetic mean)[e]	15 μg/m^3	Same as primary

Source: 40 CFR Part 50

a. Not to be exceeded more than once per year.
b. To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.075 parts per million.
c. The annual standard for PM_{10} was revoked by the EPA in 2006.
d. Not to be exceeded more than once per year on average over 3 years.
e. To attain this standard, the 3-year average of the weighted annual mean $PM_{2.5}$ concentrations from single or multiple community-oriented monitors must not exceed 15.0 μg/m^3.
f. To attain this standard, the 3-year average of the 98^{th} percentile of 24-hour concentrations at each population-oriented monitor within an area must not exceed 35.0 μg/m^3.

EPA = U.S. Environmental Protection Agency.
mg/m^3 = milligrams per cubic meter.
μg/m^3 = micrograms per cubic meter.
ppm = parts per million.

The nearest area where air quality is more stringently protected than typical ambient air quality standards is the Great Sand Dunes National Park in southeastern Colorado, approximately 230 miles (370 kilometers) west of the Biorefinery Project site.

To estimate existing air quality, DOE obtained air pollutant concentration levels from the EPA Air Quality System and the EPA Clean Air Status and Trends Network. The Air Quality System is a database of air pollutant data collected by state, local, and tribal organizations. The Clean Air Status and Trends Network is a nationwide air quality and meteorological monitoring network operated to collect rural, regionally representative air pollutant levels.

Air quality monitoring data specific to the Stevens County area are limited; therefore, air pollutant data measured in Kansas, Oklahoma, and Texas were assembled and analyzed to estimate existing air quality. Data were selected as representative of Hugoton based on land use, geography, and exposure. Table 3-4 lists the background values of five criteria pollutants. The background values are all below the National Ambient Air Quality Standards.

Table 3-4. Ambient criteria pollutant background levels representative of the Hugoton area.

Pollutant	Averaging times	Background	Monitoring site
Carbon monoxide	1-hour	2.0 ppm (2,300 $\mu g/m^3$)	Newkirk, OK
	8-hour	0.5 ppm (570 $\mu g/m^3$)	Newkirk, OK
Nitrogen dioxide	Annual	0.004 ppm (8.0 $\mu g/m^3$)	Sumner County, KS
Ozone	4^{th} highest daily maximum	65 ppb	PAL 190
Sulfur dioxide	3-hour	0.004 ppm (10 $\mu g/m^3$)	Trego County, KS
	24-hour	0.003 ppm (8.0 $\mu g/m^3$)	Trego County, KS
	Annual	0.001 ppm (3.0 $\mu g/m^3$)	KNZ184 and PAL190
Particulate matter (PM_{10})	24-hour	60 $\mu g/m^3$	AQS sites in KS/OK
	Annual	20 $\mu g/m^3$	AQS sites in KS/OK and KNZ184

Source: Lavery 2009.
AQS = EPA Air Quality System.
CASTNET = EPA Clean Air Status and Trends Network.
EPA = U.S. Environmental Protection Agency.
KNZ184 = CASTNET site in Konza Prairie, Kansas.
PAL190 = CASTNET site in Palo Duro State Park, Texas.
$\mu g/m^3$ = micrograms per cubic meter.
ppb = parts per billion.
ppm = parts per million.

3.2.2 CLIMATIC CONDITIONS

Kansas is typically described as being in a region with a *continental climate*. Continental climates describe regions that have colder winters and warmer summers, as they are not near any moderating bodies of water. Elevations in Kansas range from about 900 feet (300 meters) in the southeast to about 3,000 feet (900 meters) in the west; this elevation difference is one factor contributing to varying rainfall amounts across the state. Stevens County is located in the southwest corner of Kansas, and is therefore located in a higher elevation region (NOAA 2005).

A local weather station that is part of the National Weather Service Cooperative Station Network is operated in Hugoton, Kansas, at an elevation of 3,110 feet (950 meters). Published climate data from 1971 to 2000 at this station reports an annual mean temperature of 54.7 degrees Fahrenheit (°F) [13 degrees Celsius (°C)], with mean daily maximums of 92.7°F (34°C) in July and mean daily minimums of

17.2°F (-8.2°C) in January. Temperatures in excess of 100°F (40°C) occur on an annual average of 12.1 days per year, and subzero temperatures occur on an annual average of 4 days per year (NCDC 2004).

The mean annual precipitation total at the Hugoton station is 18.4 inches (47 centimeters), with the monthly maximum mean of 3 inches (7.6 centimeters), occurring in May and the monthly minimum mean of 0.4 inch (0.97 centimeter) occurring in February. Annually, the mean number of days with precipitation above 0.1 inch (0.25 centimeter) is 36.6. The mean annual snowfall amount is 11.5 inches (29 centimeters), with the monthly maximum mean of 3.3 inches (8.4 centimeters) occurring in January. The mean number of days per year with snowfall over 1 inch (2.5 centimeters) is 3.5 (NCDC 2004).

The closest station with available published climatic wind data is Dodge City, Kansas. Dodge City is approximately 80 miles (130 kilometers) northeast of Hugoton. The monthly average wind speed at Dodge City is 11 miles per hour (4.9 meters per second). During January to March, the prevailing wind direction is north-northwest. The prevailing wind direction is from the north during April to June and from the south for the remainder of the year. Peak wind gusts have been reported to be in the range of 48 to 79 miles per hour (21 to 35 meters per second) for a 5-second wind measurement (NCDC 1998).

Tornado activity in the Hugoton, Kansas area is below the Kansas state average, but 38 percent higher than the United States average (city-data.com n.d.). Section 4.12 of this EIS discusses tornadic activity, including tornado risks.

3.2.3 CONFORMITY

In November 1993, EPA promulgated two sets of regulations under the federal *Clean Air Act* section 176(c) to implement the concept of conformity. First, on November 24, EPA promulgated the Transportation Conformity Regulations, which apply to highways and mass transit. Then on November 30, EPA promulgated a second set of regulations, known as the General Conformity Regulations, which apply to major projects that do not fall under transportation conformity regulations but still require action of a federal agency.

Transportation conformity is required to ensure that federal funding and approval are given to highway and transit projects that are consistent with (conform to) the air quality goals established by a state or tribal air quality implementation plan. To conform to the implementation plans, the transportation activities cannot cause new air quality violations, worsen existing violations, or delay timely attainment of the national ambient air quality standards. The transportation conformity rules apply to projects receiving federal funding or approval by the Federal Highway Administration or Federal Transit Administration.

The General Conformity Regulations require federal agencies to work with state, tribal, and local governments in a nonattainment or maintenance area to ensure that federal actions conform to the initiatives established in the applicable state or tribal implementation plan. This is only applicable to projects that are considered major sources of regulated air emissions.

3.3 Geology

Geology is the scientific study of the origin, history, structure, and composition of the earth, mainly through study of its rocks, minerals, and landforms. When referencing the geology of a given geographic area, the term geology is usually interpreted as the set of physical characteristics for that given area. DOE has studied the *physiographic* setting, *stratigraphy*, *lithology*, geologic structure, energy and mineral resources, and soils at the Biorefinery Project site and in the surrounding region of influence. DOE has also studied the geologic and soils-related hazards for the region of influence. The region of influence for the geology resource area is the area within a 50-mile (80-kilometer) radius of the Project site.

This region of influence allows effective evaluation of impacts by the Proposed Action and Action Alternative as this region is consistent with the region of influence for the groundwater resource area, which is, to some extent, dependent on geology, and the geographic extent of biomass procurement activities for the biorefinery. The discussion on soils-related hazards focuses on the area of the Biorefinery Project site where potential impacts would occur. The region of influence encompasses all of Stevens, Morton, Seward, and Grant counties and portions of Stanton, Kearney, Hamilton, Haskell, Finney, Gray, and Meade counties in Kansas; a portion of Baca County in southeastern Colorado; portions of Cimarron, Texas, and Beaver counties in Oklahoma; and a very small portion of Hansford County in Texas (Figure 3-3).

3.3.1 PHYSIOGRAPHY AND GEOMORPHOLOGY

Physiography is the study of the physical features of the Earth's surface including landforms, climate, and life. *Geomorphology* is the study of the features and landforms, and the processes operating upon the Earth's surface to produce these features. Physiography and geomorphology are integrally related to geography, geology, and hydrology of a given area. The following sections discuss the physiography and geomorphology of the region of influence.

3.3.1.1 Physiography

Most of the region of influence is situated within the High Plains section of the Great Plains Physiographic Province. The characteristics of the High Plains section are typical of the physiographic setting for most of western Kansas, southeastern Colorado, and the northwestern Oklahoma Panhandle area (CGS 2008; KGS 1997a; Ryder 1996). The High Plains section within the region of influence is characterized by generally flat, eastward-sloping terrain interrupted by the drainage network of the Cimarron River. Elevations range from 4,000 feet (1,200 meters) above mean sea level in the western extent, to approximately 2,600 feet (790 meters) above mean sea level in the eastern extent. The region of influence slopes eastward at a rate of approximately 14 feet per mile (2.7 meters per kilometer), with a surface slope of approximately 11 feet per mile (2.1 meters per kilometer) in the area of the Biorefinery Project site and across Stevens County, Kansas. The smooth to slightly irregular plains of the High Plains section host a high percentage of cropland. The extreme northern extent of the region of influence includes the Arkansas River Lowlands subsection, which dissects the High Plains section. The alluvial terrace system is associated with the Arkansas River, which is characterized by sand and gravel deposits, irregular hills, and sand dunes over a wide area (NRCS 2006b).

Landforms within the region of influence consist of a large percentage of upland plains and sandhills, with a minor percentage of stream *floodplains* and intermediate slopes along drainages. The upland plains areas are broadly characterized by apparent flat and featureless surfaces; however, from a more focused perspective, the apparent flat and featureless surfaces of the upland plains consist of broad, gentle swells, hills, and shallow *depressions*. The sandhills in Stevens County occur on the southern and eastern

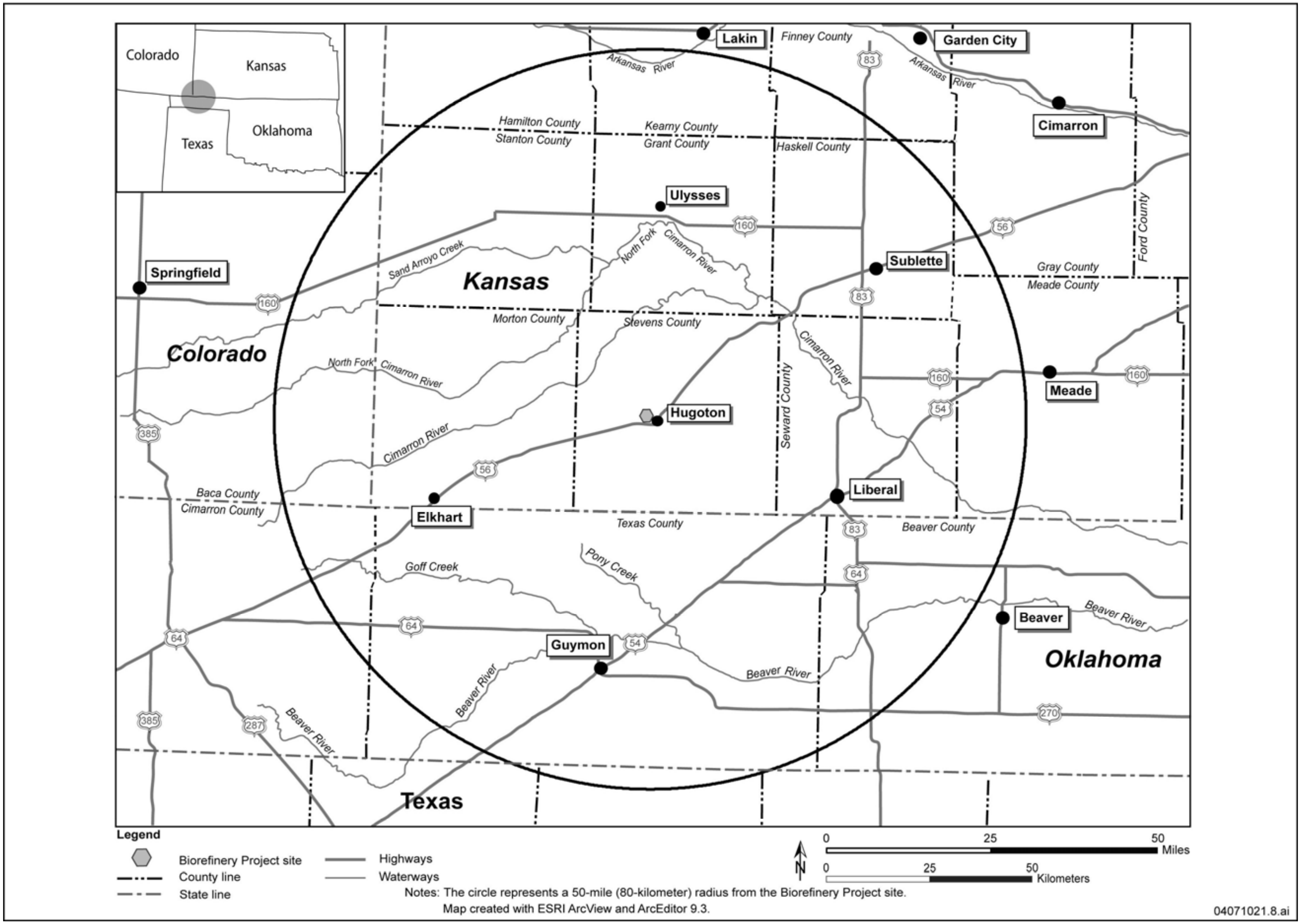

Figure 3-3. 50-mile (80-kilometer) region of influence showing county outlines.

sides of the Cimarron River. Grass-stabilized sand plains, dunes, and sand sheets of *eolian* origin characterize the sandhill landforms. The sandhill topography is characterized as hilly or rolling. Dunes comprising the sandhills differ in age and size, with the larger dunes being on the order of 20 feet (6 meters) or more in height (NRCS 2006b).

Stream floodplains and intermediate slopes are characteristics of drainages that incise the upland plains areas. These features are associated with the major drainages in the region of influence including the Cimarron River and its primary tributary, the North Fork of Cimarron River in Kansas; and the Beaver River and tributaries in Oklahoma. Drainages such as the Cimarron River average slightly over 100 feet (30 meters) below the adjacent upland elevation across the region of influence with increasing relief from west to east (NRCS 2006b).

3.3.1.2 Geomorphology

Unconsolidated Cenozoic deposits comprise much of the surface geology in the area. As discussed in the following sections, the unconsolidated Cenozoic deposits originated through the erosion of the Rocky Mountain Uplift area to the west with sediments transported and deposited downslope via easterly trending *fluvial* systems.

Current land-surface features are represented by eolian, or windblown, loess and coarser sand deposits, and alluvial deposits associated with current drainages. The significant thicknesses of Cenozoic deposits present in the region of influence represent sediment transportation, reworking, and additional deposition beginning in the late Tertiary Period, over a period of approximately 24 million years to create the generally broad and gently sloping land surface observed today (Ryder 1996). More recent fluvial stream action is significantly less than in the recent geologic history, but has continued to incise drainages such as the Cimarron River and continues to transport sediment in an eastward, downslope direction.

The geomorphology in the vicinity of the Biorefinery Project site in Stevens County is characterized as broad upland essentially devoid of surface drainage with dominant cover by sand dunes in various stages of development (McLaughlin 1946).

3.3.2 REGIONAL GEOLOGY/GENERAL GEOLOGIC HISTORY

The following sections describe geology with respect to geologic history for the region of influence and the stratigraphy, lithology, and geologic structure of the Cenozoic as related to the important *aquifers* of the area.

3.3.2.1 Regional Geology and Geologic History

The geology of the region of influence is generally characterized as an area underlain by thick deposits of limestone, shale, sandstone, clay, sand, and gravel, and lesser amounts of salt, gypsum, and anhydrite. The deposits range in thickness from 5,000 to 6,000 feet (1,500 to 1,800 meters) and are located above Precambrian igneous and metamorphic basement rock. Based on drilling logs from the region of influence obtained through hydrocarbon resource exploration, the underlying formations relate to geologic time periods including the Paleozoic, Mesozoic, and Cenozoic eras (Figure 3-4).

Kansas Geologic Timetable
(not scaled for geologic time or thickness of deposits)

Eras	Periods	Epochs	Est. Length (Years)[a]	Description	Million Years Past
Cenozoic	Quaternary	Holocene	10,000+	Early, the land was stable with some erosion. Glaciers moved into the northeast at least twice. Later the climate was dry. Sand dunes were formed by wind in the west. Volcanic ash was blown in from California, New Mexico, and Wyoming.	
		Pleistocene	1,590,000		1.6
	Tertiary	Pliocene	3,700,000	Rocks found are part of the Ogallala Formation (sand, gravel, and porous rock), which contains a large quantity of groundwater and occurs only in the western third of the state. No rocks were formed in eastern Kansas.	
		Miocene	18,400,000		
		Oligocene	12,900,000		
		Eocene	21,200,000		
		Paleocene	8,600,000		66.4
Mesozoic	Cretaceous		77,600,000	Much of the western half was covered by seas. Limestone, sandstone, and chalk formed from sea deposits. Fossils can be found in these rocks, which crop out in central and western Kansas.	144
	Jurassic		64,000,000	Most rock in Kansas is underground in the west. A few small outcrops are found in the southwest corner.	208
	Triassic		37,000,000	No rocks have been found in Kansas.	245
Paleozoic	Permian		41,000,000	Much of Kansas was covered by several seas. As they rose and fell, limestone, shale, and chert were deposited. The Flint Hills were formed. When the seas dried up, salt and gypsum were left behind. Salt, now underground, is mined in central Kansas. The Red Hills were formed from deposits of shale, siltstone, gypsum, and dolomite.	286
	Pennsylvanian		34,000,000	For much of the period the land was flat. Seas and swamps came and went; coal formed in swamps from dead plants. Shale, limestone, sandstone, chert, and conglomerates were deposited. Two ridges of hills, the Nemaha uplift and the Central Kansas uplift, appeared; both are now burried. Pennsylvanian rocks are found at the surface in eastern Kansas.	320
	Mississippian		40,000,000	Repeated layers of limestone, shale, and sandstone indicate that seas rose and fell. Mississippian rocks are the oldest found at the surface and are in the southeast corner; elsewhere these rocks are only underground.	360
	Devonian		48,000,000	Seas covered Kansas during much of the period. Limestone, shale, and sandstone deposits are only underground.	408
	Silurian		30,000,000	Land was uplifted and seas disappeared. Limestone deposits are found only underground.	438
	Ordovician		67,000,000	Seas covered Kansas during much of the period. Limestone, shale, and sandstone deposits are only underground.	505
	Cambrian		65,000,000	Early, the climate was dry and many rocks eroded. Later, parts of Kansas were covered by seas. Dolomite, sandstone, limestone, and shale are now underground.	570
Precambrian			3,930,000,000	These rocks are the oldest on earth. In Kansas, they are only found deep below the surface and not much is known about them. Many are igneous and metamorphic and have gone through many changes.	4,500+

Note: Eons not shown.
a. From Decade of North American Geology, 1983 Geology Time Scale. Geological Society of America. Kansas Geological Survey. Lawrence, Kansas 1988.

Source: KGS 1997b.
04071022.4.ai

Figure 3-4. Kansas geologic timetable.

In general, younger rock formations are formed in sequence over older rock formations and are typically found in the same association provided the formations are not thrusted, faulted, or overturned through structural modification. The rock units within the region of influence increase in age from the surface down based on information from geologic exploration. Recent Quaternary deposits (for example, stream deposits along rivers) are among the youngest, and Precambrian igneous and metamorphic rock represents the oldest rock type in the overall vertical section, or geologic record, of the subsurface.

Surface geology consists of various ages of dunes and dune sand across much of the area except areas of Quaternary alluvium along drainages such as the Cimarron River and areas of Quaternary surficial loess deposits, mainly north of the Cimarron River. In the area of the Biorefinery Project site, surficial dune sand is described as deposits in the old-age stage of the dune cycle, consisting of fine, reddish sand that is moderately well indurated. The dunes in the area form broad and gentle undulations and have a thick soil. The dune sand lies above the water table and does not yield water to wells but serves as a catchment area for recharge of the groundwater *reservoir* (McLaughlin 1946).

3.3.2.2 Stratigraphy, Lithology, and Geologic Structure

The stratigraphy within the region of influence is discussed from oldest formations to the most recent. The oldest rock type is the Precambrian igneous or metamorphic basement rock. This rock type can be observed in the study area only by drill cuttings and/or deep cores. Paleozoic Era sedimentary deposits overlie the Precambrian basement rock. The Paleozoic Era strata present consist of Cambrian, Ordovician, Mississippian, Pennsylvanian, and Permian System limestones, shales, mudstones, and sandstones. Devonian and Silurian age deposits are reported as not present in the study area and may have been removed by erosion prior to deposition of geologically younger strata (McLaughlin 1946). The Paleozoic strata are overlain by Mesozoic deposits, specifically the Cretaceous Dakota, Kiowa, and Cheyenne Sandstone formations, and the Jurassic Morrison Formation. Cenozoic deposits consisting of Tertiary and Quaternary undifferentiated terrace, alluvial, *colluvial*, and eolian sediments overlie bedrock in the study area. The thicknesses of these more recent Cenozoic sediments extends to more than 500 feet and consists of unconsolidated clay, silt, sand, and gravel. The unconsolidated Tertiary and Quaternary sediments present in the study area collectively comprise the High Plains aquifer of the region.

The consolidated bedrock surface and strata in the region of influence generally slopes to the east-northeast, away from the Sierra Grande uplift in Baca County, southeastern Colorado. There are two well-known fault zones in southwestern Kansas, the Crooked Creek-Fowler fault zone and the Bear Creek fault zone. These fault zones are further discussed in Section 3.3.5.2.

3.3.3 MINERAL AND ENERGY RESOURCES

The *economic geology* of a given area refers to the geologic resources that are considered of value. Such resources could include hydrocarbons, ores, evaporates (such as halite and gypsum), aggregate, and many other valued resources extracted from the earth. DOE has studied the economic geology of the region of influence; the following sections discuss the findings.

3.3.3.1 Energy Resources

Energy resources within the region of influence consist primarily of natural gas and crude oil. Hydrocarbon production can be found essentially throughout the region of influence. The majority of production is associated with the Hugoton Embayment, which is considered a shallower, northern extension of the deeper Anadarko Basin. The value of the gas and oil produced in the 14 counties of southwest Kansas that comprise the Hugoton Embayment area exceeds 50 percent of the total value of gas and oil produced in Kansas (Carr et al. 2003).

The Hugoton production extends south through the Oklahoma panhandle area, including Texas, Beaver, and portions of Cimarron counties in Oklahoma. Production in these areas is predominantly natural gas, with some oil and oil and gas production combined (Boyd 2002). Hydrocarbon production also occurs in southeastern Colorado. Baca County, Colorado, reports production of both oil and natural gas (COGCC n.d.).

Stevens County is situated over the predominant overlapping Hugoton Gas Area and Panoma Gas Area natural gas fields that cover several counties in southwestern Kansas. Natural gas production in the Hugoton Gas Area is primarily from formations in the Permian Chase Group; production in the Panoma Gas Area is from the slightly older Permian Council Grove Group. Natural gas and oil in the vicinity of the Biorefinery Project site are produced from the Hugoton and Panoma gas areas, in addition to limited production from older Mississippian formations of the Gentzler Field.

The Biorefinery Project site is approximately 810 acres (3.3 square kilometers) in area. The site consists of a 385-acre (1.6-square-kilometer) parcel on which the biorefinery would be located and a 425-acre (1.7-square-kilometer) buffer area east and adjacent to the biorefinery parcel. There are two plugged and abandoned natural gas wells, two producing natural gas wells, and one gas and oil combined production well located within the biorefinery area (in Section 18, Township 33 South, Range 37 West) and one gas and one gas and oil combined production wells in the southern portion of Section 18, outside the biorefinery parcel. There is one producing gas well located in Section 17, Township 33 South, Range 37 West, and one producing oil and gas well and two *cathodic protection wells* within the buffer area. Cathodic protection wells are not producing wells, they are used to protect metallic objects in contact with the ground, such as pipelines or well casings from electrolytic corrosion. An additional producing gas well and two cathodic protection wells are located in the northeast quarter of Section 17, outside the boundaries of the buffer area (Figure 3-5). Production wells located in Sections 17 and 18 have reported production from the Gentzler, Panoma, and Hugoton fields (KGS n.d.).

3.3.3.2 Mineral Resources

Mineral resources within the region of influence are generally limited to sand and gravel aggregate and volcanic ash. Quarrying for sand and gravel is typically expected to occur along the Cimarron and North Fork Cimarron rivers, and is used primarily for road materials. Currently, there is only one reported active sand and gravel quarry in Stevens County, operated by the Stevens County Road Department. There are several abandoned sand and gravel quarrying operations in Stevens County and other Kansas counties within the region of influence. Each Kansas county within the region of influence appears to host at least one active sand and gravel quarry operation (KGS 2003).

Deposits of volcanic ash occur in multiple locations in Grant County and one location in Haskell County. The mining of volcanic ash appears to be a historical operation, as there are no reported active volcanic ash mining operations within the region of influence (McLaughlin 1946; KGS 2003).

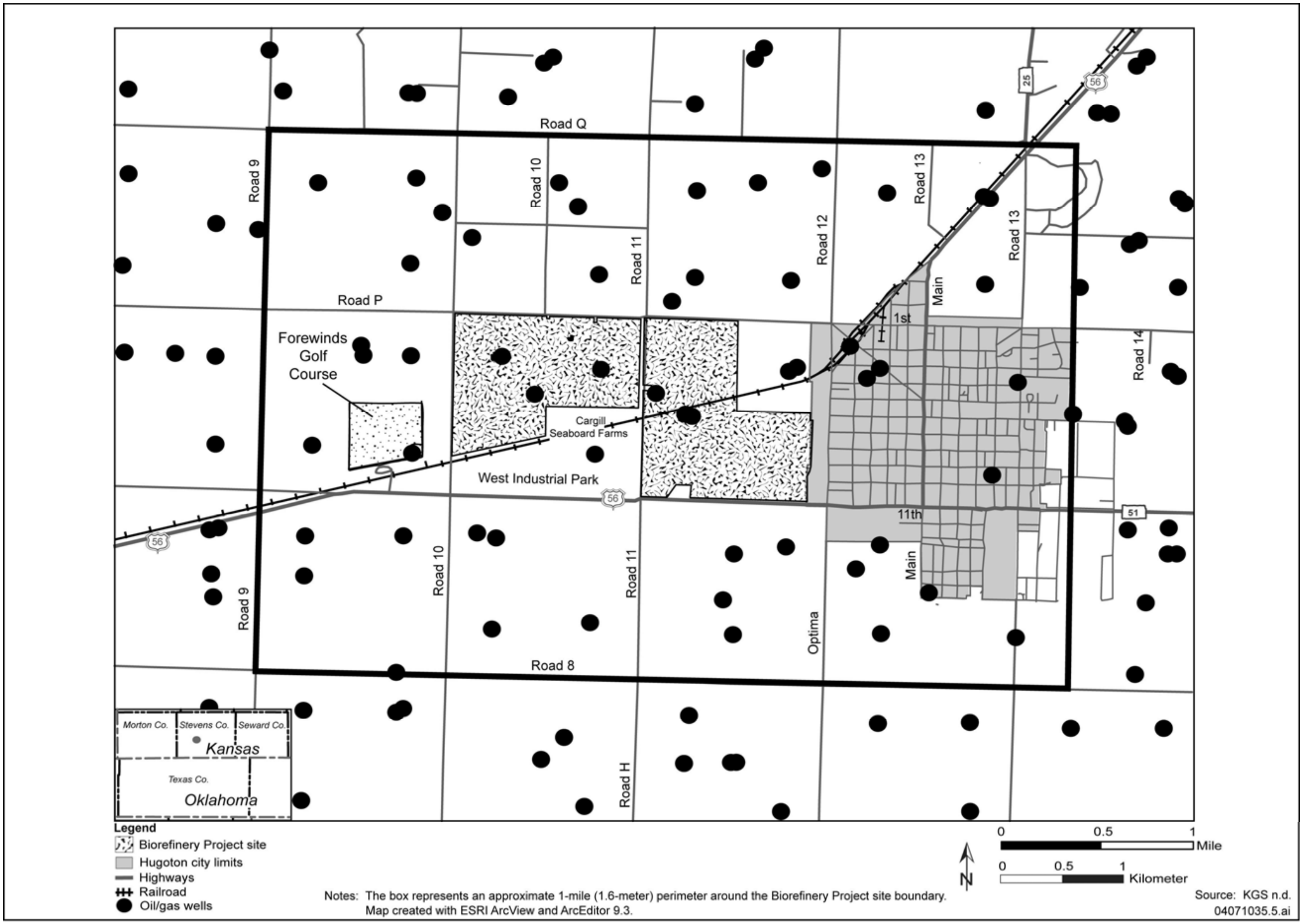

Figure 3-5. Locations of oil and gas wells on and in the vicinity of the Biorefinery Project site.

3.3.4 SOILS

Variations in soil types within an area are found in orderly patterns related to the geology, landforms, relief, climate, and natural vegetation in the area. Soils within the region of influence, as described in the following paragraphs, have been derived primarily from loess and dune sand deposits, consistent with the nature of the shallow subsurface geology of the area. Soils derived from loess are generally dark and compact clay-type soils, where soils derived from dune sand are very sandy and susceptible to wind erosion (McLaughlin 1946).

Soil types from three series—Belfon, Canina, and Vorhees—occur within the Biorefinery Project site (NRCS 2006b). The soil types are the Canina *loam*, 0 to 1 percent slopes (5205), Belfon loam, 0 to 1 percent slopes (5210), and the Vorhees fine sandy loam, 1 to 3 percent slopes (1611).

The Canina Series consists of very deep, well-drained soils that formed in loamy, calcareous eolian loess deposits of Holocene age. These soils are nearly level to very gently sloping plains with slopes of 0 to 3 percent. Permeability of Canina soils is moderate. Canina soils are used extensively as cropland, with some minor areas used as improved pasture or rangeland.

The Belfon Series consists of very deep, well-drained soils that also formed in loamy, eolian loess deposits of Holocene age. Slopes range from 0 to 2 percent and permeability is moderate. Belfon soils are used extensively as cropland with some minor areas used as improved pasture or rangeland. The Belfon Series soil type, Belfon loam 0 to 1 percent slopes, is considered prime farmland if irrigated.

The Vorhees Series consists of very deep, well-drained soils that formed in calcareous, loamy eolian sediments of late Pliestocene to Holocene ages. Vorhees soil slopes range from 1 to 5 percent. Permeability of Vorhees soils is moderate. Vorhees soils are mainly used as cropland with a few small areas used as improved pasture or rangeland (NRCS 2006b).

The USDA NRCS defines prime farmlands as lands that have the best combination of physical and chemical characteristics needed to economically produce sustained high-yield agricultural crops [7 CFR 657.5(a)]. Of the three primary soil types within the Biorefinery Project site, approximately 243 acres (1 square kilometer) of the 385-acre (1.5-square-kilometer) tract consists of the Belfon loam, 0 to 1 percent slopes, which is considered prime farmland if irrigated. However, the acreage in Section 18 is not irrigated and is therefore not considered prime farmland. Approximately 317 acres (1.3 square kilometers) of the 425-acre (1.7-square-kilometer) buffer area is irrigated Belfon loam, 0 to 1 percent slopes, and is considered prime farmland. Although not found in the footprint of the Project site, one other soil type, the Forgan loam, 0 to 1 percent slopes, is also considered prime farmland if irrigated. Irrigated Forgan loam 0 to 1 percent slopes soil type is found within 1 to 2 miles of the Project site.

The NRCS defines a *hydric soil* to be a soil that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (NRCS 2008a). The presence of hydric soils is one of the three characteristics required for consideration as a wetland (see Section 3.4.1). Review of the NRCS Stevens County List of Hydric Soils indicated three soil types occurring in the County are identified as hydric soils: Happyditch loamy fine sand, Feterita clay, 0 to 1 percent slopes, and Ulysses silt loam, 0 to 1 percent slopes (NRCS 2009). These soil types qualify as hydric in association with *playas* or depressions. None of these hydric soil types occurs within the Biorefinery Project site. Hydric soils in the semiarid region of influence generally are sparse and associated with depressions and playas (Figure 3-6).

3.3.5 SOILS- AND GEOLOGIC-RELATED HAZARDS

Soil-related hazards relate to the potential for highly erosive soils, expansive soils, and otherwise unstable soil masses. *Geologic hazards* include natural or manmade conditions or phenomena that present a risk or potential danger to life and property and include such phenomena as landslides, earthquakes, and subsidence related to *karst geology* and mining. DOE studied the potential geologic and soils-related hazards for the region of influence and the following sections discuss the findings.

3.3.5.1 Soils-Related Hazards

DOE has evaluated soil information obtained through the USDA within the region of influence in Kansas, Oklahoma, and Colorado. This information has been generated and documented through soil surveys performed by the USDA. Much of the soil data has been computerized and is accessible for query on specific soil attributes through the USDA Soil Survey Geographic database (NRCS 2008b). In addition, soil attribute information can be accessed via published soil surveys for specific counties within a given state.

The detailed review of soil-related hazards has been limited to Stevens County, Kansas. This focused area has been selected as soils-related hazards are relevant within the Project site development area due to construction and other surface disturbance.

DOE has selected several soil characteristics with potential for environmental impact implications for presentation in the EIS. These selected soil attributes include expansive soils, highly erodible soils, and unstable soil masses (fill). The following paragraphs describe these attributes.

The *shrink-swell* attribute is a gauge of the expansive nature of soil, or how much the volume of a soil changes when the moisture content changes. Linear extensibility is the physical property term used in the Stevens County soils database and is used to determine shrink-swell potential for soil. Accordingly, the shrink-swell potential is low if the soil has a linear extensibility of less than 3 percent, moderate if 3 to 6 percent, high if 6 to 9 percent, and very high if more than 9 percent. If the linear extensibility is more than 3 percent, shrinking and swelling can cause damage to buildings, roads, and other structures and to plant roots. Of the three soil series identified in the vicinity of the Biorefinery Project site (Section 3.3.4), only the Vorhees Series contains horizons with linear extensibility greater than 3 percent. There are two horizons of the Vorhees that profile 20 to 40 inches (51 to 102 centimeters) and 40 to 80 inches (102 to 203 centimeters) in depth with extensibility values reported as 0.9 to 3.9 percent. There are other soils in Stevens County with linear extensibility values in the moderate and high range. The shrink-swell properties of soil, even if moderate or high, does not mean that construction cannot or should not occur on those soils, it simply means that construction designs and plans should account for the unique physical properties of the soils. Shrink-swell character in soils is typically evaluated through *geotechnical* investigations prior to construction of buildings, tanks footings, roads, and bridges as a basis for foundation design (NRCS 2006b).

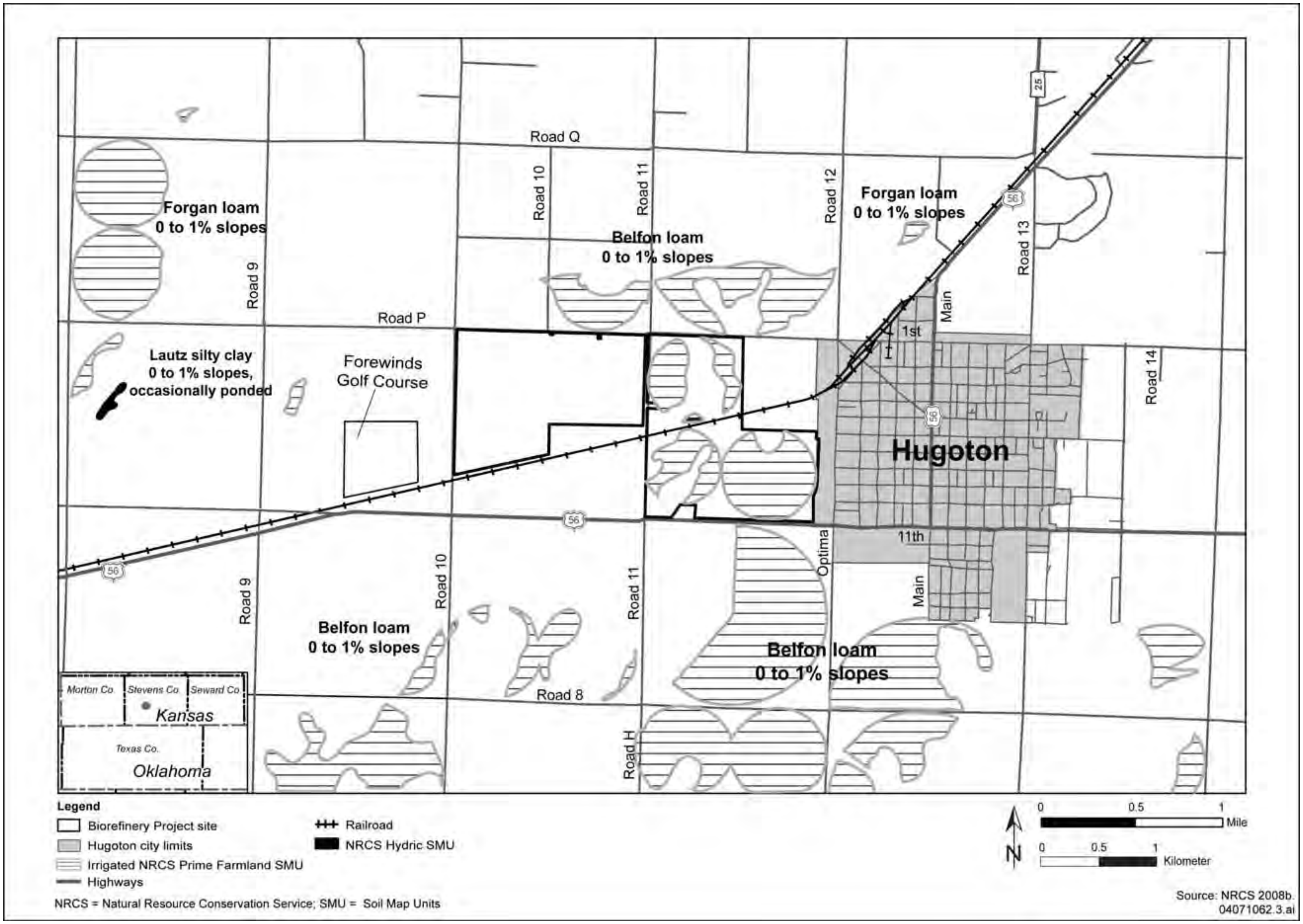

Figure 3-6. Natural resources, including prime farmland if irrigated and hydric soils.

The highly erodible attribute is a measure of the susceptibility of bare soil to be detached and moved by wind or water. Erosion by water, that is, by sheet and rill erosion, is based on a factor designated as "K." K is further differentiated as Kw, erodibility of the whole soil including rock fragments, and Kf, erodibility of the fine-earth fraction of the soil (less than 2 millimeters in diameter). Values of K range from 0.02 to 0.69. All other factors being equal, a higher K value indicates more susceptibility to erosion by water. The main properties affecting this attribute are soil texture, organic material structure, and permeability. The maximum reported K value for the soils in the vicinity of the Biorefinery Project site is 0.37, which is a mid-range value suggesting the soil types are moderately erodible by water and not highly erodible. Erosion of soil by water would likely occur when soils are disturbed or bare, but would be addressed during construction according to storm water pollution prevention plans as required by federal and state regulations. Runoff and erosion management measures with monitoring are components of the plans that are designed to minimize erosion during construction.

Wind erosion is another mechanism for potential soil loss that DOE evaluated. The Kansas State Soil Geographic database includes classification of soil types in terms of susceptibility to wind erosion. Soils are assigned to groups called Wind Erodibility Groups. There are eight groups, numbered 1 through 8 with Group 1 being the most susceptible to wind erosion and Group 8 being the least. The Vorhees Series has been assigned to Group 3, with the Canina assigned to Group 5, and Belfon assigned to Group 6. The wind erodibility groups are based on wind erosion affecting the soil type when exposed as cultivated land.

The *unstable fill* attribute is a measure of a soil's tendency to move when it is wet or loaded, or both. Unstable fill can also be suitable for use as subgrade material or fill based on several physical and engineering properties including shrink-swell, shear, plasticity, particle size with respect to composition, and other variables. The USDA Soil Survey Geographic database provides classification of soil with respect to its use as a source of road fill, which identifies limitations based on soil engineering and physical properties. The Vorhees Series is classified as "Good," the Canina and Belfon series are classified as "Poor" based on low strength and shrink-swell, in terms of use as a source of road fill. As with foundation design, suitability of material used for backfill typically is subjected to physical property analysis to ensure that the final, compacted fill meets design specifications. Further, geotechnical analysis of soils on slopes that could be unstable would allow for appropriate design response.

3.3.5.2 Geology-Related Hazards

Geology-related hazards for the region of influence are considered to include seismic, landslide, and subsidence phenomena. DOE has studied these potential geologic hazards, and the following paragraphs discuss the findings.

Earthquake hazard is typically considered to relate to earthquake shaking action and ground motion. Ground shaking and movement during an earthquake may occur in multiple vectors but is defined with respect to a single value termed peak ground acceleration (USGS 2008a). Peak ground acceleration, typically expressed in units of percent gravity, is the maximum amplitude of recorded acceleration. Peak ground acceleration relates to maximum acceleration experienced during the course of an earthquake motion in terms of horizontal acceleration with respect to the force (acceleration) of gravity. Hazard potential for a given area is usually expressed as peak ground acceleration with a percent probability of exceedance in a given timeframe.

Figure 3-7 presents a seismic hazard map for Kansas (USGS 2008b). Stevens County, including the area of Hugoton, Kansas, is located in an area with a peak ground acceleration value in the range of 4 to 6 percent, based on a 2-percent probability of exceedance in 50 years.

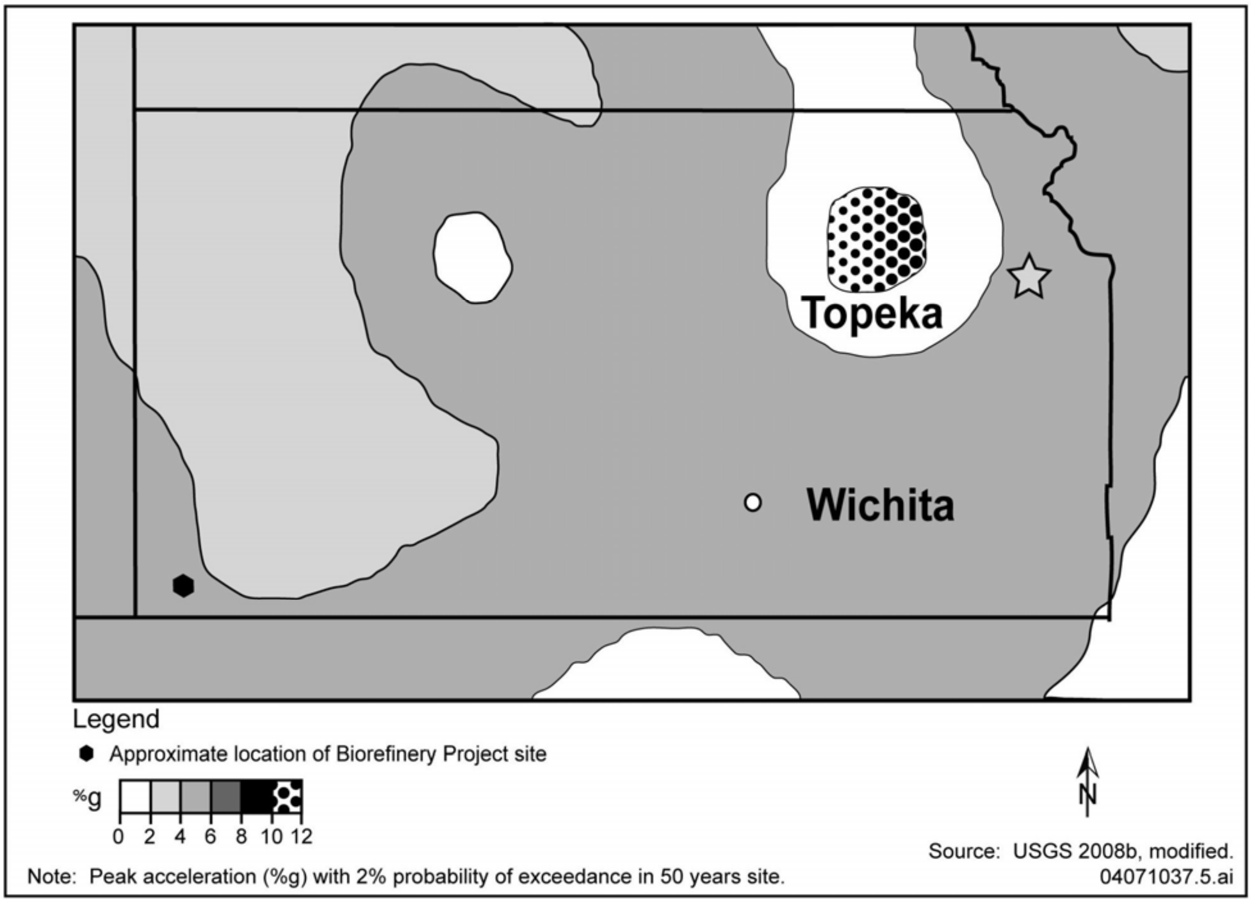

Figure 3-7. Seismic hazard map for Kansas.

There are two well-known fault zones in the region of influence, in southwestern Kansas: the Crooked Creek-Fowler fault zone and the Bear Creek fault zone. The Bear Creek fault zone is located in northern Stanton and Grant counties, approximately 40 miles (64 kilometers) north of Hugoton. The Crooked Creek-Fowler fault zone is in Meade County, approximately 55 miles (88 kilometers) east of Hugoton. These fault zones historically have been interpreted as structural faulting of bedrock strata based on early observations of surface features (such as lineal sinks and depressions). These fault zones are more recently considered to relate to *subsidence* with localized minor faulting associated with dissolution of Permian evaporites (salt) during late Tertiary or early Quaternary time, and likely do not represent postdepositional faulting of consolidated sediments (Young et al. 2005).

Landslides hazards, or landslides, are a form of earth movement downslope under gravity loads that can be triggered by external forces or environmental conditions. Gravity landslides can be triggered by the force of gravity coupled with moisture changes. Earthquake-generated landslides also involve gravity, and the landslide is triggered by earthquake shaking action. Information on potential landslide hazards for the region of influence is somewhat limited; however, based on a review of the USGS Landslide Overview Map of the Conterminous United States (Radbruch-Hall et al. 1982), the region of influence falls within an area of low landslide incidence (less that 1.5 percent of area involved), and susceptibility for landslides is the same or less than the incidence valued. Considering landslides relate to downslope earth movement, the vicinity of the Biorefinery Project site would be expected to have low susceptibility based on the relatively flat terrain.

Soil collapse, the lowering or collapse of the land surface either locally or over regional areas, can be caused by dissolving subsurface limestone or other soluble materials, underground mining, or withdrawal of subsurface fluids. Karst is a unique landscape developed as a result of dissolution of limestone or other soluble materials in the subsurface; surficial expressions of karst geology typically includes the formation of sink holes. Stevens County is located either within or adjacent to an area designated as not exhibiting karst geology, but exhibiting pseudo-karstic features with fissures and voids present to a depth of 250 feet (76 meters) or more in areas of subsidence from piping in thick, unconsolidated material. In the extreme northwestern area of the region of influence, there is a minor area with potential for Karst occurring in gently dipping to flat-lying carbonate rock (Davies et al. 1984). Underground mining (as a source for soil collapse or subsidence) is not known to occur in the area of Stevens County nor is there known volcanic activity in the area.

3.4 Hydrology

Hydrology is the study of the properties, distribution, and effects of water on a planet's surface, in the soil, and in the atmosphere. This section describes the current hydrologic conditions within the area of the Biorefinery Project site and associated regions of influence in terms of surface water and groundwater system characteristics. Section 3.4.1 describes current surface water conditions and Section 3.4.2 describes current groundwater conditions.

3.4.1 SURFACE WATER

This section describes the surface water conditions in the region of the Biorefinery Project site. The region of influence considered for surface water includes areas of construction or other land disturbance that could be susceptible to erosion, areas affected by permanent changes in infiltration or runoff, and areas downstream of the Project site that could be affected by eroded soil or potential spills of contaminants. To incorporate the offsite biomass storage locations, the region of influence is the land area within a 30-mile (48-kilometer) radius of the Project site.

Specific locations for the *offsite storage locations* have not yet been established. However, to protect the value of the materials held in those locations, the storage sites would not be located in depressions where runoff could accumulate, nor would they be located over or adjacent to drainage channels that could overflow or hinder access.

3.4.1.1 Surface Water Features and Drainage Patterns

On the scale of the country's major surface water drainages, the Biorefinery Project site lies south of the Arkansas River, a primary tributary to the Mississippi River, and north of the Canadian River, the largest tributary to the Arkansas River. Both the Arkansas and Canadian rivers originate in Colorado and flow in an easterly-southeasterly direction toward the Mississippi. Figure 3-8 shows the Arkansas and Canadian

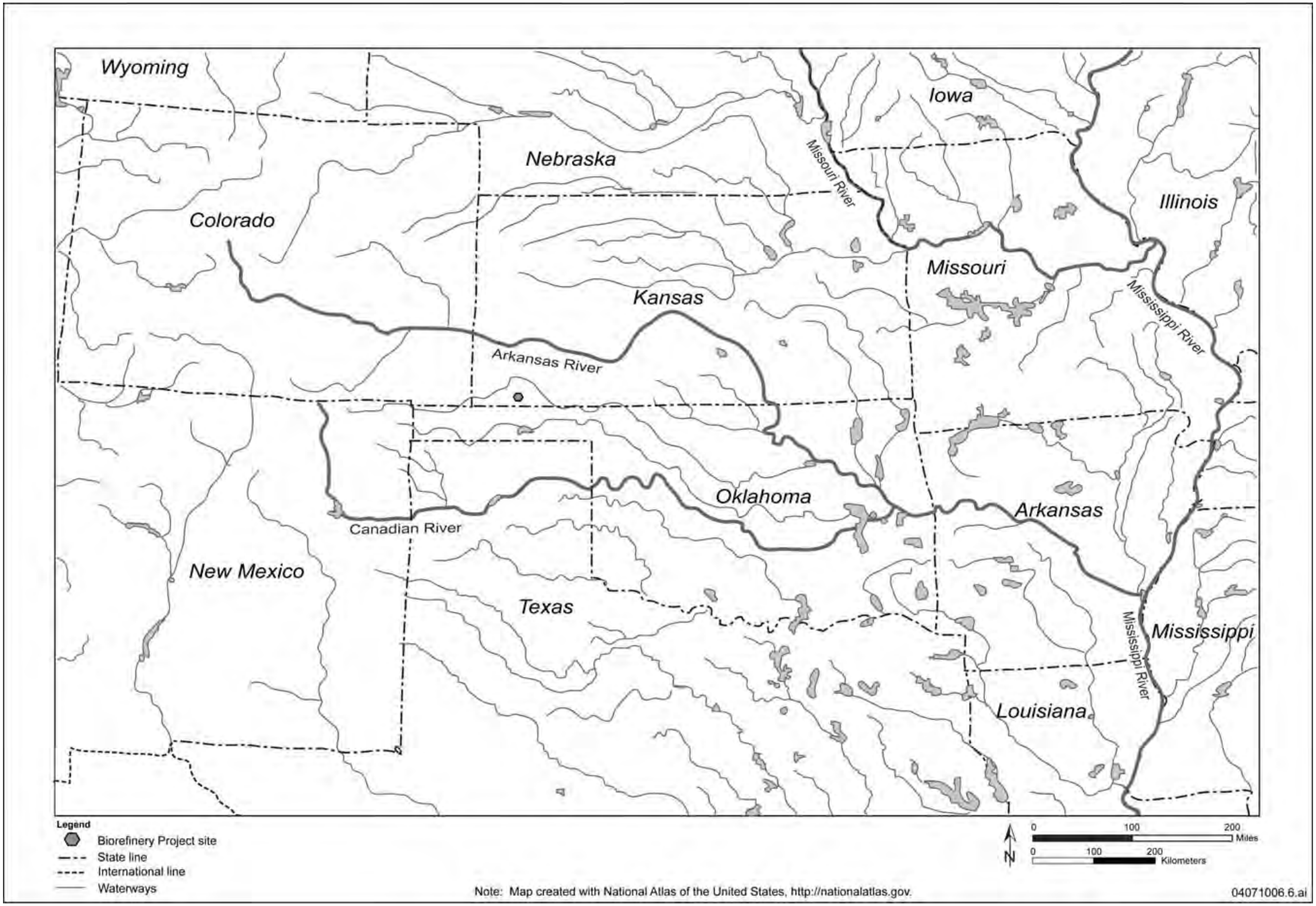

Figure 3-8. Major river systems bordering the region of influence.

rivers along with the states through which they flow. The figure also shows the Mississippi River, into which the Arkansas flows, as well as other, smaller rivers that are addressed later in this section.

The USGS has divided the nation into *hydrologic units* consisting of 21 major regions which are then subdivided into subregions, accounting units, and finally into the smallest element of the hierarchy, the cataloging unit (Seaber et al. 1987). The cataloging units are sometimes called *watersheds*. Both the USGS and EPA use this hierarchy of hydrologic units to track water and water-related information. The Biorefinery Project site is located within Region 11, the Arkansas-White-Red Region, which covers 245,500 square miles (635,800 square kilometers) and comprises the Arkansas, White, and Red river basins above the points of highest backwater effect of the Mississippi River. Region 11 is subdivided into 14 subregions and the Project site is within Subregion 1104, Upper Cimarron, which stretches from the Cimarron River’s headwaters to the River’s most downstream intersection with the Kansas-Oklahoma state line, covering 12,000 square miles (31,000 square kilometers). Accounting Unit 1104000 is identified with the same name and area as Subregion 1104. Within Subregion 1104 there are eight cataloging units or watersheds, and Hugoton and the Project site are within the catalog unit designated Upper Cimarron-Liberal and assigned the hydrologic unit code 11040006 (Seaber et al. 1987). Hydrologic Unit Code 11040006 covers 1,720 square miles (4,500 square kilometers); is primarily in Kansas, but extends into Oklahoma; and on its east side includes the portion of the Cimarron River in Seward and Meade counties in Kansas. The State of Kansas uses this same hierarchy of defining hydrologic units in its surface water planning, tracking, and regulating efforts (KDHE 2007a).

3.4.1.1.1 *Streams and Rivers in the Region of Influence*

Surface water features are very limited within the 30-mile (48-kilometer) region of influence. Based on a review of the 60 USGS 7.5-minute quadrangle topographic maps (http://topomaps.usgs.gov/index.html) that cover the area, the closest, named surface water feature to the site is the Cimarron River, which originates far to the west of the Biorefinery Project site, loops to the north around the site, then turns back to the southeast toward the Oklahoma state border (Figure 3-9). At its closest, the channel of the Cimarron River is about 8.5 miles (14 kilometers) to the northwest of the Project site. The North Fork Cimarron River lies on the north side of the Cimarron River; in the region of influence, the North Fork runs roughly parallel to the Cimarron River until the two join at a point northeast of the Project site. Sand Arroyo Creek is a named tributary to the North Fork Cimarron River that also occurs within the region of influence. After the North Fork and the Cimarron join, the Cimarron River continues on toward the southeast, into Oklahoma, where it joins with the Arkansas River at a location well outside the region of influence.

To the south of the Biorefinery Project site, the Beaver River (also referred to as the North Canadian River in portions of its run) is located at the region of influence boundary, and named tributaries extend into the region of influence to the southwest of the biorefinery site. These tributaries to the Beaver River include Cow Creek, Goff Creek, and Pony Creek, all located in Oklahoma (Goff and Pony creeks are shown in Figure 3-9). The Beaver River subsequently joins the Canadian River in Oklahoma before it joins the Arkansas River.

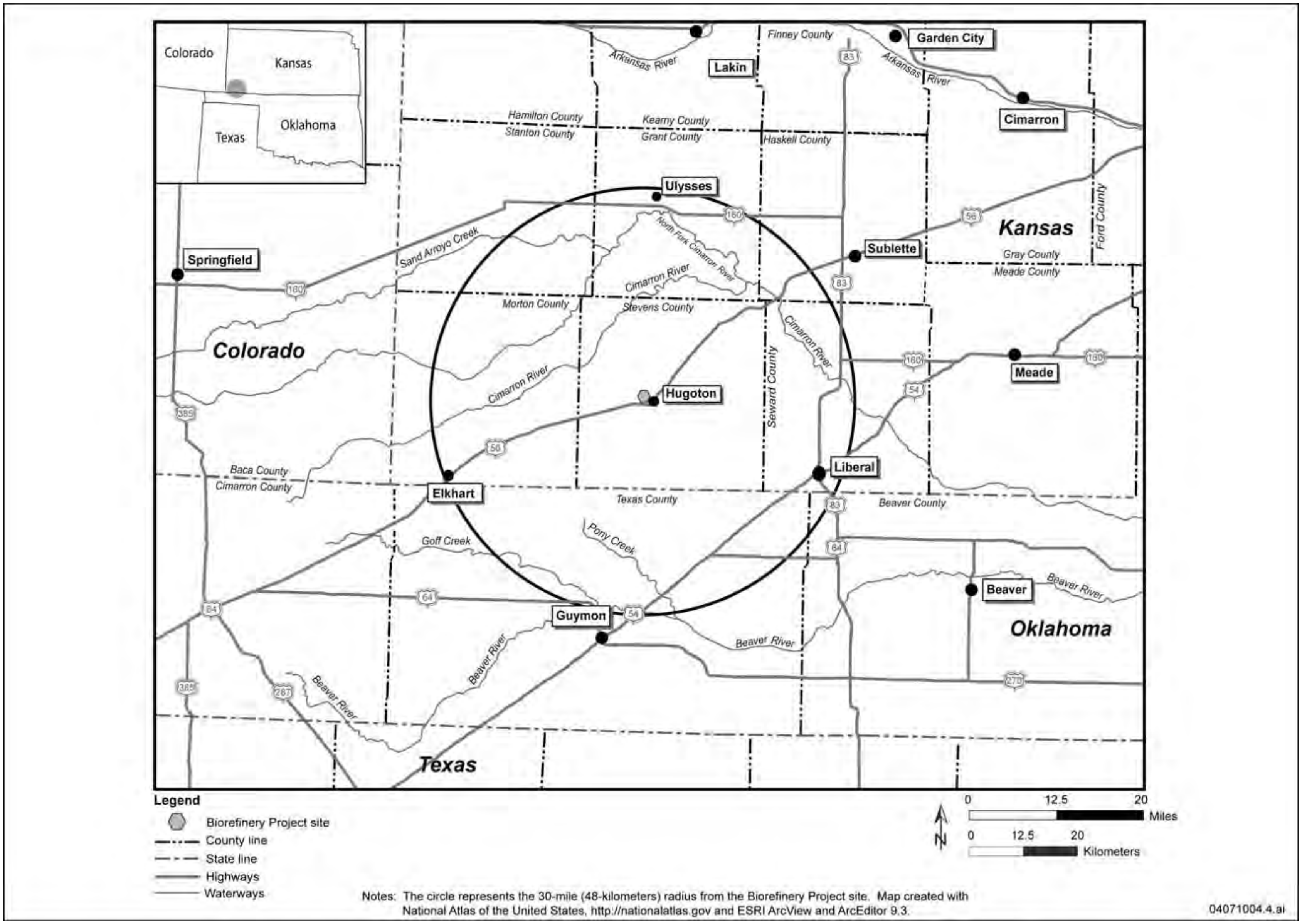

Figure 3-9. Rivers and creeks in the 30-mile (48-kilometer) region of influence.

All of the rivers and creeks inside the region of influence (that is, the Cimarron and North Fork Cimarron rivers and Sand Arroyo Creek to the north and the Cow, Goff, and Pony creeks to the south, as well as the Beaver River at the south boundary of the region of influence) flow only *intermittently* within the 30-mile (48-kilometer) region of influence in response to precipitation events and snow melt. For the three rivers and Sand Arroyo Creek, their intermittent nature can be verified by a review of stream monitoring records maintained by the USGS in the National Water Information System (USGS 2008c). This USGS database has no entries for Cow, Goff, or Pony creeks in Oklahoma, but the USGS topographic map shows each of these streams with dashed or broken blue lines, indicating they also are intermittent streams.

The recent history of the Cimarron River, the closest river to the Biorefinery Project site, is typical of other streams in the region. Stream-flow measurements in the early 1940s indicated the Cimarron River generally lost flow (to groundwater recharge) from near Elkhart [about 30 miles (48 kilometers) west-southwest of the Project site] to the northwest part of Seward County (to the northeast of the Project site), and gained flow (by groundwater seeps or springs) from northwest Seward County to southwest Meade County. In that timeframe, *perennial* flow started in the area of northwest Seward County (Young et al. 2005), about 23 miles (37 kilometers) northeast of the Project site. During the 1960s to 1975, there were significant drops in the level of the High Plains aquifer in southwest Kansas (additional information about the High Plains aquifer can be found in Section 3.4.2.1.1). A 1974 evaluation indicated the beginning of perennial flow in the Cimarron River had moved 3 to 4 miles (5 to 6 kilometers) down the channel. By 2005, the start of perennial flow had moved 11 to 12 channel miles (18 to 19 kilometers) further downstream (Young et al. 2005). The area where perennial flow now begins in the Cimarron River is almost due east of Hugoton and the Project site; at or just outside the 30-mile region of influence. The main cause of this decreased river flow is the decline of the level of the High Plains aquifer. Upstream areas of the River are no longer fed by springs and seeps from the groundwater, and the lowered groundwater level has resulted in the upstream portions of the River being groundwater recharge areas when surface water is present.

3.4.1.1.2 *Other Surface Waters*

Other than the rivers and streams identified above, the USGS 7.5-minute quadrangle topographic maps that cover the 30-mile (48-kilometer) region of influence identify few named water features. Mitchell Pond, identified as a perennial lake or pond, is located about 26 miles (42 kilometers) northeast of the Biorefinery Project site, on the east side of the Cimarron River. The only other named surface water feature within the region of influence (other than the sewage treatment ponds associated with most of the small communities) is Wild Horse Lake, a *playa* lake in Oklahoma about 17 miles (27 kilometers) south-southwest of the Project site. The playa lake, about 1 mile (1.6 kilometers) across at its widest, is shown with a dashed outline, indicating it is intermittent (that is, not perennial). There are similar, smaller playa areas shown on the topographic maps scattered throughout the region where runoff often accumulates for periods of time before evaporating or soaking into the ground.

Optima Lake (or reservoir), a manmade lake collecting water from the Beaver River from the west and Coldwater Creek from the southwest, is a prominent feature on topographic maps of the region and is located southeast of the Project site but several miles outside of the region of influence.

3.4.1.1.3 *Drainage Patterns*

Southwest Kansas has a prevailing eastward slope of about 12 feet per mile (2.3 meters per kilometer) (Young et al. 2005). Within this region, Stevens County, the location of the Biorefinery Project site, generally slopes in an east-northeasterly direction at about 11 feet per mile (2.1 meters per kilometer) (NRCS 2006b). This low slope is interrupted by drainage patterns of streams and rivers as well as subsidence along several fault zones. The Cimarron River, for example, has cut a relatively steep river valley into the surrounding terrain. At its closest point to the Project site, the applicable 7.5-minute topographic map shows the river channel is about 75 feet (23 meters) lower than the flatland above, and in southeastern Seward County the river channel is 200 feet (61 meters) or more lower than the nearest upland (Young et al. 2005).

The area of the Biorefinery Project site is within the watershed draining eastward toward the Cimarron River, while the segment of the river's channel (to the northwest) that lies closest to the Project site is in a different watershed. However, due to the flat-to-gently rolling nature of the topography, the Cimarron River and its tributaries drain only about 10 percent of Stevens County (NRCS 2006b); the rest of the County's land drains internally. That is, the great majority of the County's land area has no access to a drainage system that would transport runoff out of the area. The general fate of runoff water in the area surrounding the Biorefinery Project site and most of Stevens County is that it flows into depressions in between the land swells, where it evaporates or soaks into the ground. The depressions are often referred to as *interdunal depressions* because they are located between the remnant swells of the sand dunes that once covered the area.

A depression covers much of the 425-acre (1.7-square-kilometer) buffer area between Hugoton and the area where the biorefinery would be constructed. The depression covers most of the northern portion of the buffer area and extends into the southwest quarter of the section to the north of the buffer area. The lowest area of the depression is within the buffer area, and the topographic map shows a small pond in this lowest area with a solid outline indicating it is perennial water. A recent field investigation of this area concluded that this drainage depression does not contain a perennial pond, but rather collects water only intermittently (Section 3.4.1.4).

3.4.1.2 Surface Water Quality

Although surface water in the region of influence is limited, some water quality information is available. For example, water quality data are available for the Cimarron River in the area east of Liberal, Kansas. This is the only permanent, naturally occurring surface water that is located in the same watershed as the Biorefinery Project site. As part of an ongoing program to monitor and characterize surface waters of the state, the Kansas Department of Health and Environment monitored the Cimarron River in the area near its crossing into Oklahoma. Samples were collected from the River once every 2 months for the four years from 1999 through 2002. Results of the sampling data can be found in EPA's STOrage and RETrieval Database (EPA 2008a). This set of data represents the only sampling information in the database from hydrologic unit code, or watershed, 11040006 – Upper Cimarron-Liberal. Because the Cimarron River, at its closest, lies 8.5 miles (14 kilometers) from the Project site and there are no drainages from the site to the River, this EIS does not address water quality data further.

The Cimarron River within Hydrologic Unit Code 11040006, where the Project site is located, is designated as general-purpose water, while upstream within Hydrologic Unit Code 11040002 (to the north and west of the Project site) the Cimarron River is designated as an exceptional state water (KDHE 2007a). Associated with these designations, the State has identified appropriate uses for both stretches of River, has established applicable numerical standards (KDHE 2004), and periodically assesses the water quality of the River against those standards (EPA 2008b). Because there is no reasonable means by which the Proposed Action could affect these waters, this EIS does not address the applicable surface water standards further.

3.4.1.3 Surface Water Uses

There are few surface water features within the region of influence and, correspondingly, there is little in the form of documented uses of surface water. Almost all of the reported water use in the Cimarron River Basin area of Kansas is from groundwater (KWO 2009a) and that appears to be the case for at least the last 20 years (Kenny and Hansen 2004). The only permanent surface water in the same watershed as the Biorefinery Project site is the portion of the Cimarron River to the east and northeast of Liberal, Kansas that is at or just outside the boundary of the 30-mile (48-kilometer) region of influence. This portion of the Cimarron River is designated for aquatic life and recreational use.

The *National Water Summary 1987* (Carr et al. 1990) describes water use in Oklahoma by county. Texas and Beaver are the only Oklahoma counties within the 30-mile (48-kilometer) region of influence, and they are shown with surface water withdrawals in the lowest category [in this case 0 to 1 million gallons (0 to 3,800 cubic meters) per day]. There are no records or other indications of significant surface water use within the region of influence.

3.4.1.4 Floodplains and Wetlands

3.4.1.4.1 *Floodplains*

The EIS analysis includes a query of the Federal Emergency Management Agency online Map Service Center (FEMA 2008) for the existence of flood maps in any of the Kansas or Oklahoma counties within the 30-mile (48-kilometer) region of influence. When a state and county are selected on the flood map site, key communities within the county and generally a single entry for the unincorporated areas of the county are listed or identified in the onscreen response. Clicking on one of the listed items identifies available flood maps, which can then be viewed. There are no Federal Emergency Management Agency-issued flood maps for Stevens County. Hugoton and Moscow, as well as the unincorporated area of Stevens County, are identified in the Map Service Center's database, but each is listed with no flood maps available. Starting with Morton County, Kansas to the west of Stevens County and proceeding in a clockwise manner, flood map information for the surrounding counties is described as follows:

> **ZONE A FLOOD ZONE**
>
> On Federal Emergency Management Agency flood maps, Zone A designates those areas that would be under water from a 100-year flood.

- Morton County, Kansas – The database identified Elkhart and Rolla as well as the unincorporated area of Morton County; only Elkhart is listed with any flood maps available. The Flood Insurance Rate Map covering Elkhart shows Zone A flood zones (areas within a 100-year flood) along the railroad tracks in town and along Hooster Avenue to the north. These flood zones appear to be associated with a depression where runoff would accumulate rather than from flooding of any specific surface water feature. Elkhart is just inside the 30-mile (48-kilometer) region of influence.

- Stanton County, Kansas – The database identified Ulysses and the unincorporated area of Stanton County; each is listed with no flood maps available.
- Grant County, Kansas – The database identified Johnson City and Manter as well as the unincorporated area of Grant County; each is listed with no flood maps available.
- Haskell County, Kansas – The database identified Sublette and Satanta as well as the unincorporated area of Haskell County; each is listed with no flood maps available.
- Seward County, Kansas – The database identified Kismet and Liberal as well as the unincorporated areas of Seward County; each is listed with flood maps available. Kismet is outside the 30-mile (48-kilometer) region of influence. The maps of Liberal showed multiple Zone A flood zones throughout the community, and each appears to be identified as either a playa or a ditch running between playas. That is, the flood-prone areas identified are associated with depressions where runoff would accumulate rather than from flooding of any specific surface water feature. The database listed multiple flood maps covering the unincorporated area of Seward County. These maps showed a Zone A flood zone extending on either side of the Cimarron River for its entire length through the County (from the border with Haskell County in the north to the border with Meade County in the southeast). These maps also showed flood zones extending up into the primary drainage channels flowing into the Cimarron channel. Finally, the maps showed flood-prone areas throughout the County in the depressions where runoff would accumulate (not associated with flooding of any specific surface water feature).
- Beaver County, Oklahoma – Beaver is the only entry for Beaver County in the database, and it includes a single flood map. The database did not show an entry for the unincorporated portion of Beaver County. Beaver is well outside the 30-mile (48-kilometer) region of influence.
- Texas County, Oklahoma – The database identified Goodwell, Guymon, Hooker, and Texhoma as well as the unincorporated area of Texas County. Only Goodwell and Guymon had any flood map coverage; there is no coverage for the unincorporated portion of Texas County. Goodwell is outside the 30-mile (48-kilometer) region of influence as is Guymon, but Guymon is close enough that it warrants a description. The flood map covering Guymon showed a Zone A flood zone associated with Dry Sand Draw, which runs northward on the west side of the town, draining into the channel of the Beaver River. The flood zone of the Dry Sand Draw incorporates Sunset Lake on the west side of the city. There are a few other relatively narrow flood zones on the north side of the town that appear to be associated with smaller drainage channels running toward the Beaver River. Just northeast of Guymon, the Beaver River is at the boundary of the 30-mile region of influence.

Based on the regional information for areas where mapping has been performed, it is likely that the unmapped areas contain additional flood zones. The Cimarron River, North Fork Cimarron River, and Sand Arroyo Creek to the north of the Biorefinery Project site, and Pony Creek, Cow Creek, Goff Creek, and Beaver River to the south would have flood zones along their channels. However, these river or creek channels are far enough away that associated flood zones would not be expected to reach the Project site. The closest river channel to the site is that of the Cimarron River about 8.5 miles (14 kilometers) to the northwest and, as described previously, its channel has been cut well below the surrounding upland areas, so its flood levels would not extend laterally any great distance.

In those areas not covered by flood maps, there would be many areas that consist of depressions where runoff accumulates. Were these areas to be mapped, these depressions would likely be shown as flood zones in the Federal Emergency Management Agency maps, as they were in the flood maps described above. However, the definition of a floodplain included in Executive Order 11988, *Floodplain Management* and paraphrased in DOE's corresponding regulation (10 CFR Part 1022), is "the lowland and relatively flat areas adjoining inland and coastal waters including flood-prone areas of offshore islands." Although the depressions and playa areas would be of local concern with regard to construction and other land uses, they would not be considered floodplains. In the case of the depression in the 425-acre (1.7-square-kilometer) buffer area of the Project site, it has been managed as agricultural land, which is common for the other low playa areas in the surrounding region.

The *Kansas Water Plan* describes flood concerns, management, and planning activities in Kansas (KWO 2009b). The Plan describes floodplain maps as a major component of the management program and identifies those counties within the state that are considered a priority for floodplain mapping or remapping. Stevens County is not on that list, and of the aforementioned surrounding Kansas counties, only Seward is on the list. According to the *Kansas Hazard Mitigation Plan* (KDEM 2007), 10 of the 12 river basins of the state are designated "priority" for rural flood loss reduction. Among other factors, areas within these basins were identified as priority concerns based on historical flood damage and the percentage of the watershed occupied by floodplains. The Cimarron Basin was one of two basins in the state with no priority areas identified. It can be concluded from this information that the area of Stevens County that surrounds the Biorefinery Project site is not considered to be an area with serious flooding issues.

3.4.1.4.2 *Wetlands*

The National Wetlands Inventory Map maintained by the U.S. Fish and Wildlife Service (http//www.fws.gov/wetlands) shows a mapped area within the northern portion of the 425-acre (1.7-square-kilometer) buffer area of the Project site as a potential wetland. The inventory identifies the site as "Palustrine, Unconsolidated Bottom, Semi-permanently Flooded, Excavated" and lists it as 1.5 acres (0.0061 square kilometer) in size. This location corresponds to an intermittent pond shown on the applicable 7.5-minute topographic map for the area. The inventory map also shows a smaller [0.3-acre (0.0012-square-kilometer)] site, with the same designation, just outside the east boundary of the 425-acre buffer area.

A wetland survey and assessment was conducted on the northern portion of the buffer zone. The resulting report of the survey and assessment is included with this EIS as Appendix D. The assessment concluded that the area does not qualify as a *jurisdictional wetland* and has been farmed in most years. As a result, the report indicates a *Clean Water Act* Section 404 permit should not be required for any dredge or fill-type work that might be performed in the area, but that the U.S. Army Corps of Engineers has the final determination. On November 10, 2008, Abengoa delivered the Wetlands Assessment Report to the Kansas State Regulatory Office of the Corps of Engineers for their concurrence or comment (Roach 2008a).

JURISDICTIONAL WETLAND

Wetlands are “those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas” [40 CFR 230.3(t)].

A jurisdictional wetland is one that is within the jurisdictional limits of authority of the U.S. Army Corps of Engineers under the *Clean Water Act* because the wetland also qualifies as a water of the United States. Waters of the United States include all waters that are currently used, or were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of the tide; all interstate waters; and all other waters the use, degradationl or destruction of which could affect interstate or foreign commerce (33 CFR 328.3). Work in waters of the United States, including the discharge of dredged or fill materials, is regulated by the Army Corps of Engineers through issuance of permits.

The wetland assessment report does not include an evaluation of the smaller “Palustrine, Unconsolidated Bottom, Semi-permanently Flooded, Excavated site” [that is, the 0.3-acre (0.0012-square-kilometer) site] because it is located outside either parcel of land that would be part of the Biorefinery Project site, and would not be impacted by the Proposed Action. Runoff from the biorefinery area would not be able to reach the east offsite wetland area, but rather would flow to the low playa area in the buffer zone. Based on observations made during the wetland survey, the small area adjacent to the east boundary of the buffer area appears to have been excavated to create an irrigation return water pond and can be described as a manmade, low-quality, isolated wetland.

3.4.2 GROUNDWATER

Water supply for almost all uses within the region of influence, and much of the surrounding areas of western Kansas, western Oklahoma, and southeastern Colorado, is derived from groundwater. DOE has studied the groundwater hydrology within the region of influence, which consists of an area within a 50-mile (80-square-kilometer) radius from the Biorefinery Project site. This region of influence includes the area designated for biomass procurement for biorefinery operations, and allows for sufficient description and effective evaluation of direct and indirect impacts by the Proposed Action and Action Alternative. Discussion of the groundwater resource is focused on the High Plains aquifer, with increasing detail in the area of the Project site.

3.4.2.1 Groundwater Sources

The primary source of groundwater in the region of influence is the High Plains aquifer. Other groundwater sources and aquifers within the region of influence are used, to some degree, in areas where they underlie the High Plains aquifer. These aquifers are consolidated bedrock aquifers and those of significance in terms of water availability and adequate quality for *consumptive irrigation*, stockwatering, municipal, and domestic use include the Dakota aquifer and the Morrison-Dockum aquifer. The following sections discuss these aquifers with emphasis on the primary High Plains aquifer groundwater source.

3.4.2.1.1 *High Plains Aquifer*

The High Plains aquifer is also commonly referred to as the Ogallala aquifer. The High Plains aquifer includes the Ogallala aquifer and other adjacent or associated geologic units that constitute an *unconfined aquifer*, hydraulically connected to the saturated deposits below the water table (Macfarlane 2000). The High Plains aquifer is extensive, underlying an area of approximately 174,000 square miles (450,000 square kilometers) in parts of eight states including Wyoming, South Dakota, Nebraska, Kansas, Colorado, Oklahoma, New Mexico, and Texas (Gutentag et al. 1984). Figure 3-10 depicts the extent of the High Plains aquifer.

Consisting of younger, more geologically recent deposits, the High Plains aquifer is typically encountered above consolidated bedrock strata varying in age based on pre-aquifer deposition surface features. Depth to the aquifer can vary significantly from near (or discharging at) land surface to over 100 feet (30 meters) from surface elevation, as observed in the region of influence. The consolidated bedrock strata underlying the aquifer generally establish the lower aquifer boundary.

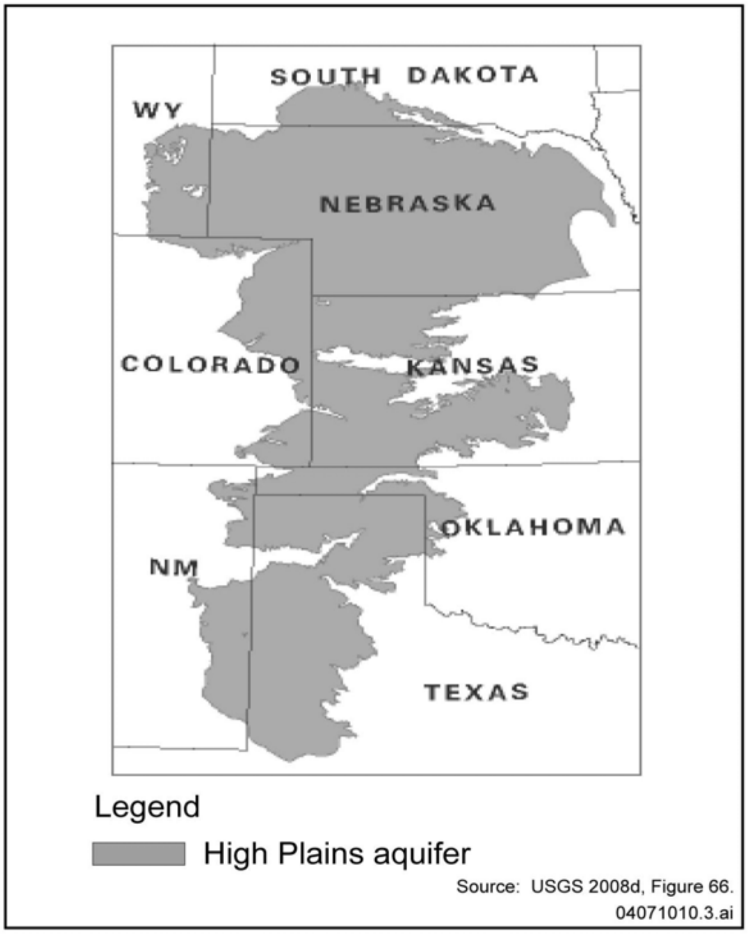

Figure 3-10. Extent of the High Plains aquifer.

The saturated thickness of the aquifer varies significantly across its entire extent. The maximum saturated thickness is around 1,000 feet (300 meters) and the average saturated thickness is about 200 feet (61 meters). Groundwater flow in the High Plains aquifer is generally from west to east (Weeks et al. 1988).

Prior to development of the aquifer for its extensive agricultural use, the groundwater system within the aquifer was in equilibrium in terms of long-term natural recharge primarily from precipitation over the geographic extent of the system, with natural discharge along the eastern aquifer boundary to streams and springs. With extensive development for irrigation over time and withdrawal of groundwater in annual volumes exceeding annual recharge, water tables have declined. The aquifer was used for irrigation beginning in the late 1800s with more significant development for irrigation beginning in the 1940s. Annual groundwater pumpage for irrigation increased from about 4 million acre-feet (5 billion cubic meters) in 1949 to about 18 million acre-feet (22 billion cubic meters) in 1980 (Weeks et al. 1988). Annual groundwater pumpage for irrigation from the High Plains aquifer in 2000 has been estimated at approximately 19 million acre-feet (23 billion cubic meters) (USGS 2008e). Yields to wells from the High Plains aquifer in Kansas can easily range to over 1,000 gallons (3,800 liters) per minute (McLaughlin 1946).

3.4.2.1.2 *Other Aquifers*

The other aquifers within the region of influence include the Dakota aquifer and the Morrison-Dockum aquifer, both of which are consolidated bedrock-type aquifers (Macfarlane 2000). While the region of influence captures portions of the southern extent of these aquifers, the aquifers do not underlie the Biorefinery Project site.

3.4.2.2 Regional and Site Groundwater

Physical properties, hydraulic characteristics, and other aquifer-specific properties vary for the primary aquifer within the region of influence. The following discussion presents pertinent aquifer-specific data for the High Plains aquifer.

3.4.2.2.1 *Saturated Thickness*

The saturated thickness of the High Plains aquifer is geographically variable. Such variability existed prior to development and use of the aquifer based on geologic conditions, including thickness of unconsolidated deposits, bedrock depths and elevations, and areas of higher and lower recharge and discharge. More recent saturated thicknesses reflect declines related to withdrawal of water from the aquifer. Figure 3-11 shows the High Plains aquifer saturated thickness in southwest Kansas averaged for 2003, 2004, and 2005 data. The saturated thickness in the area of the Biorefinery Project site ranges to over 300 feet (91 meters).

The saturated thickness of the High Plains aquifer in Texas and Beaver counties in Oklahoma, based on 1998 data, has a similar distribution to that in Kansas, ranging from less than 50 feet (15 meters) to over 400 feet (120 meters) (Luckey and Becker 1999). High Plains aquifer saturated thickness in southeastern Colorado was reported to range from 0 to 100 feet (30 meters) in 1980 (Gutentag et al. 1984).

3.4.2.2.2 *Aquifer Physical Characteristics*

The High Plains is generally a permeable aquifer. The aquifer's *hydraulic conductivity* is a measure of the rate at or ease with which water can move through a permeable medium. For a given saturated thickness, as the horizontal hydraulic conductivity increases, the potential yield to a well increases. The hydraulic conductivities within the region of influence in southwest Kansas range up to 200 feet (61 meters) per day. High Plains aquifer hydraulic conductivity in Beaver and Texas counties in Oklahoma is

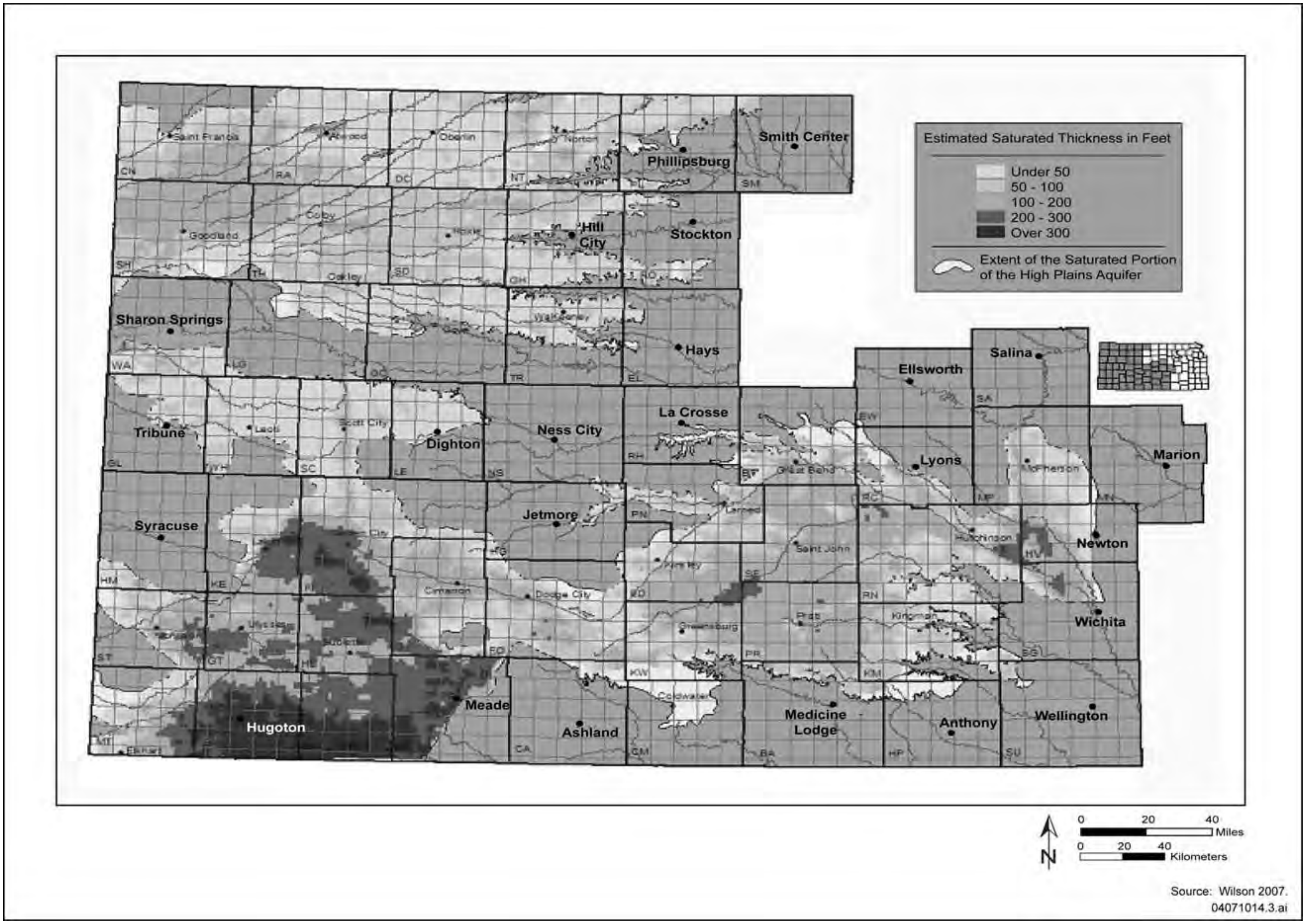

Figure 3-11. Average 2004 to 2006 saturated thickness of the High Plains aquifer in southwestern Kansas.

reported to range from 16.2 to 19.3 feet (4.9 to 5.9 meters) per day (Becker et al. 1997), and an average of 60 feet (18 meters) per day in Colorado and New Mexico (USGS 2008d).

An aquifer can be considered a reservoir of water storage, with recharge being the addition of water to the reservoir and discharge being the exit or withdrawal of water from the reservoir. If the discharge exceeds the recharge over an extended period, storage volume is reduced. As with other aquifer-specific variables, recharge is variable across the region of influence. Potential sources of recharge to the High Plains aquifer in Kansas include rain and snowmelt runoff, surface-water sources (leakage from streams, playas, floods, return water from irrigation), lateral flow within the aquifer, and cross-formational flow from adjacent aquifers. Recharge estimates for the High Plains aquifer have been reported to range from 0.024 inch (0.06 centimeter) per year in part of Texas to 6 inches (15 centimeters) per year in south-central Kansas, with higher recharge estimates in areas of sandy soils (Gutentag et al. 1984). Table 3-5 presents an accumulation of estimated annual recharge values by county within the region of influence for southwestern Kansas.

The estimated recharge rate for the area of Texas and Beaver counties in Oklahoma is 0.23 inch (0.58 centimeter) per year (Becker et al. 1997). Estimated recharge rates in Colorado were about 0.07 inch (0.11 centimeter) per year over much of the aquifer area, with areas near some streams having estimated recharge rates of 0.8 to 1.0 inches (2 to 2.5 centimeters) per year (USGS 2008d).

Table 3-5. Estimated recharge to the High Plains aquifer for select Kansas counties.

County	Recharge estimates [inches (centimeters) per year]		
	KGS	KWRB	USGS
Stevens	(a)	0.31 (0.79)	0.75 (1.9)
Morton	(a)	0.31 (0.79)	0.49 (1.2)
Meade	0.27 (0.69)	0.28 (0.71)	0.96 (2.4)
Stanton	0.30 (0.76)	0.32 (0.80)	0.39 (1.0)
Haskell	(a)	0.31 (0.79)	0.98 (2.5)
Grant	0.30 (0.76)	0.30 (0.76)	0.73 (1.8)
Gray	(a)	0.32 (0.80)	0.94 (2.4)
Finney	(a)	0.23 (0.58)	0.58 (1.5)
Kearny	(a)	0.24 (0.61)	0.50 (1.3)
Hamilton	(a)	0.10 (0.25)	0.18 (0.5)

Source: Sophocleous 2004, Table IV-1
a. Indicates counties for which recharge had not been qualified.
KGS = Kansas Geologic Survey.
KWRB = Kansas Water Resources Board.
USGS = U.S. Geological Survey.

3.4.2.2.3 *Saturated Thickness Decline*

Groundwater levels within the High Plains aquifer have been in decline because of agricultural irrigation over an extended period and the relatively low rate of recharge compared with the higher volume of groundwater withdrawal. A USGS professional paper (Gutentag et al. 1984) reports that annual pumpage up to 2 to 100 times greater than annual recharge has caused large water level declines in the High Plains aquifer. The professional paper also concluded that water levels had declined more than 100 feet (30 meters) from predevelopment to 1980 in parts of Kansas, New Mexico, Oklahoma, and Texas, an area totaling 2,500 square miles (6,500 square kilometers). Water levels had declined more than 50 feet (15 meters) in areas totaling 12,000 square miles (31,000 square kilometers), and more than 10 feet (3 meters) in areas totaling 50,000 square miles (130,000 square kilometers). Figure 3-12 presents the interpreted

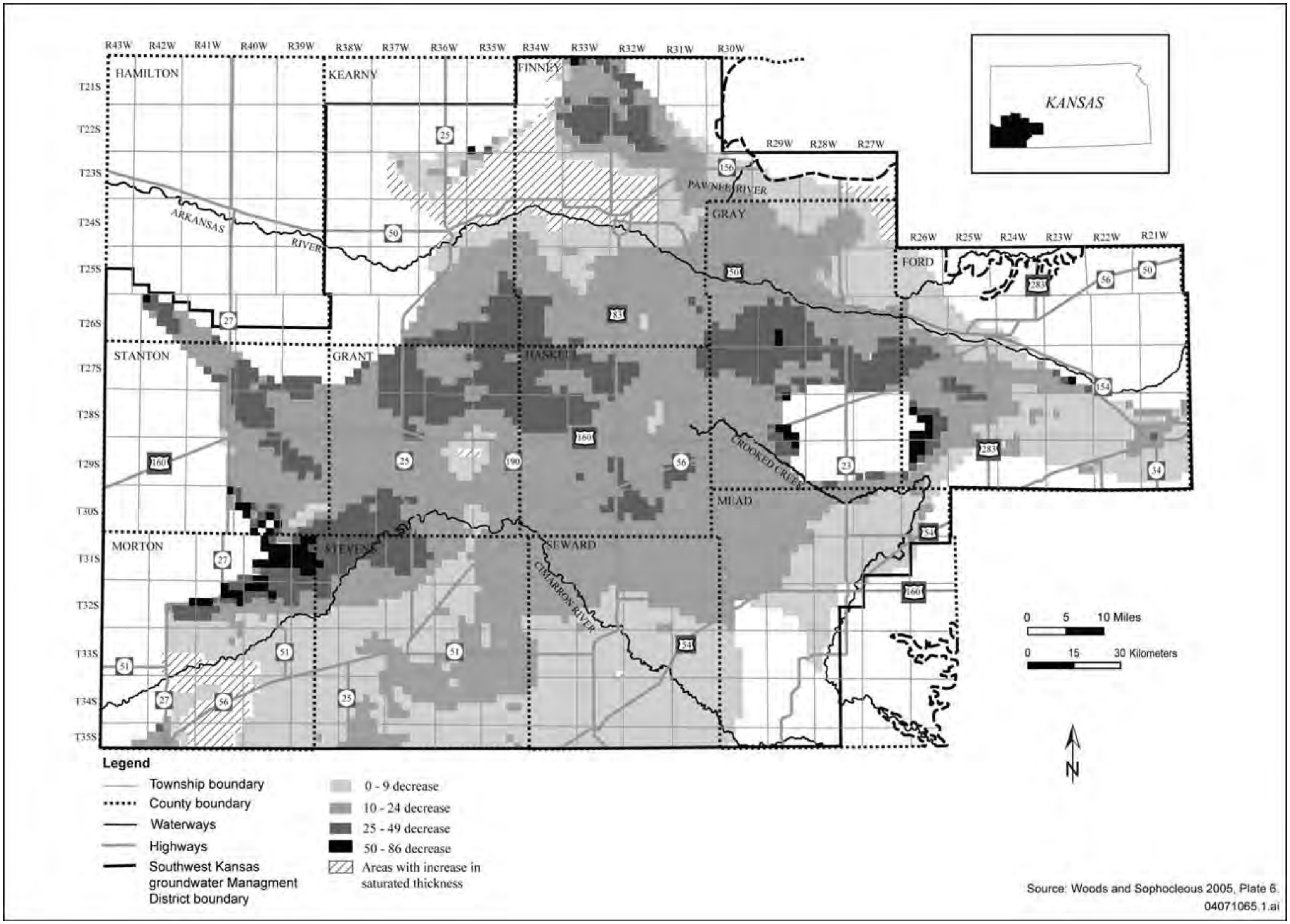

Figure 3-12. 1979 to 1981 through 1999 to 2001 change in saturated thickness of the High Plains aquifer in southwestern Kansas.

change in saturated thickness of the High Plains aquifer in southwest Kansas from 1979 to 1981 through 1999 to 2001.

Figure 3-12 indicates an approximate water decline for the 20-year period prior to 2001 of 9 to 10 percent in the area of the Biorefinery Project site. Water level declines were generally 7 to 13 percent east of Hugoton in Stevens County. The level of decline decreased to the west of Hugoton, with reported areas of water level increases in Morton County, just northeast of Elkhart, Kansas (Woods and Sophocleous 2005). Water level declines were greater in the northwest and northeast corners of Stevens County approaching the Cimarron River. Water level declines have also occurred in Texas and Beaver counties in Oklahoma. The mean High Plains aquifer water level decline in northwestern Oklahoma from predevelopment to 1998 was 11.2 feet (3.4 meters), with ranges from a rise of almost 20 feet (6 meters) to declines of almost 110 feet (34 meters). The mean water level decline in Texas County for the same period was 31.5 feet (9.6 meters); for Beaver County, a mean water level decline of 1.5 feet (0.46 meters) (Luckey and Becker 1999). According to USGS studies (McGuire 2007), much of the High Plains aquifer in southeastern Colorado has not experienced substantial change in water levels from predevelopment to 2005, plus or minus 10 feet (3 meters) of change.

3.4.2.2.4 *Aquifer Sustainability and Depletion*

Aquifer sustainability and depletion concerns do exist for the High Plains aquifer in southwestern Kansas, as in other areas of the aquifer's extent. Figure 3-13 depicts a projection of the usable lifetime of the High Plains aquifer in the southwestern Kansas area. The projection is based on the number of years until the aquifer reaches a point where a well requiring 400 gallons (1,500 liters) per minute to operate would be impaired by reduced water levels if the documented groundwater usage trends established from 1996 to 2006 remained constant into the future (Wilson 2007). The projection suggests a wide variation in southwestern Kansas with some areas already below the projection threshold. In other areas, such as in the vicinity of the Biorefinery Project site, the projected usable life of the aquifer is from 100 to 250 years.

3.4.2.3 Groundwater Quality

The naturally occurring quality of groundwater in the High Plains aquifer is generally good. The groundwater quality is suitable for irrigation use, but may exceed regulatory standards or guidelines for dissolved solids, chloride, sulfate, and fluoride in parts of the aquifer in all states. In 1984, approximately 62 percent of the High Plains aquifer contained water with between 250 and 500 milligrams per liter (parts per million) dissolved solids, but only 3 percent of the aquifer exceeded 1,000 milligrams per liter. The higher-total dissolved solids concentrations are typically associated with discharge from underlying bedrock (Gutentag et al. 1984).

In 2000, much of the aquifer within the region of influence in Kansas contained less than 500 milligrams per liter (parts per million) of total dissolved solids, with minor areas in Morton and Stevens counties with total dissolved solids concentrations between 500 and 1,000 milligrams per liter (parts per million) (Whittemore et al. 2000). Analytical data from the City of Hugoton public supply system indicate that total dissolved solids concentrations have recently ranged between 400 and 500 milligrams per liter (the EPA secondary maximum contaminant level is 500 milligrams per liter). The City reported no violations of *Safe Drinking Water Act* guidelines or requirements (Hugoton 2008).

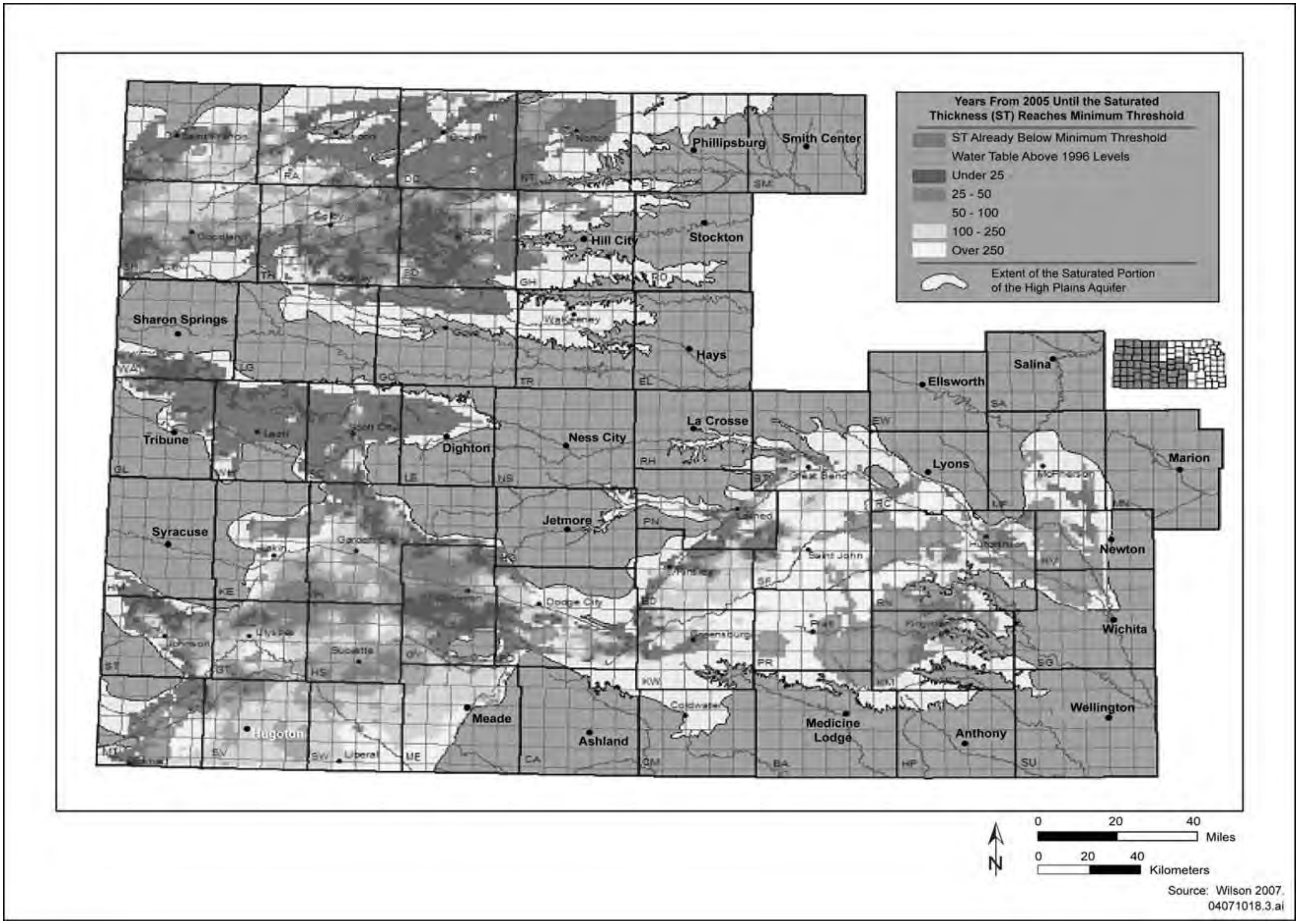

Figure 3-13. Estimated usable lifetime of the High Plains aquifer in southwest Kansas.

According to the Kansas Department of Health and Environment Identified Sites List for Stevens County, there are four closed and four active contaminated sites in Stevens County (KDHE 2008a). Two of the active sites are located in Hugoton, hydraulically downgradient from the Biorefinery Project site. The other two active sites in Stevens County include one in Moscow and one approximately 12 miles (19 kilometer) east of Hugoton. The two active sites in Hugoton have groundwater contamination by tetrachloroethene, carbon tetrachloride, and atrazine (KDHE 2008a). These sites are located east of the Project site. Contaminants released to the groundwater in association with these active sites would be expected to flow to the east away from the Project site area.

According to the Kansas Department of Health and Environment Underground/Aboveground Storage Tank Assessment Database, there are four active storage tank release sites in addition to five sites in monitoring status in or near Hugoton, Kansas (KDHE 2008b). All but two of the storage tank release sites are in Hugoton, downgradient from the Biorefinery Project site. The remaining two sites are located over 7 miles (11 kilometers) southeast of Hugoton, also downgradient from the Project site.

The Kansas Corporation Commission, Oil and Gas Division, regulates investigation and remediation of contamination to soil or groundwater caused by releases associated with the production of oil and gas. According to Commission representatives, there are no known groundwater contamination sites in Stevens County (Raines 2008; Durant 2008).

Non-point source pollution can also impair groundwater quality. Non-point pollution is not attributable to a specific release of a contaminant from a single source (*point source*) such as a catastrophic spill or release of a contaminant, but is associated with more regionalized contamination based on area-wide activity. Groundwater vulnerability to non-point pollution varies based on many factors, including the hydrogeologic setting, the types of activities involved, and the nature of the potential pollutants in terms of fate and transport in the environment. States and local governmental entities have conducted local studies on area groundwater quality; however, few aquifer-wide studies have been made (Litke 2001).

The USGS has identified changes to water quality of the High Plains aquifer attributable to non-point groundwater pollution. The percentage of observations with nitrate, a common indicator of non-point source pollution, exceeding 10 milligrams per liter (parts per million) in groundwater was less than 10 percent in Morton, Stevens, and Haskell counties and none in Grant and Stanton counties in Kansas. Baca County, Colorado, had none and Beaver County, Oklahoma, had less than 10 percent; there were no data for Texas County, Oklahoma (Litke 2001).

Data for pesticides in groundwater are sparse within the region of influence. There are a few reported detections of atrazine below drinking water standards. With regard to non-point-source pesticides, the majority of detections within the High Plains aquifer occurs in the valley-fill deposits along the Platte River in Nebraska, an area with sandy soil, intensive cropping, and shallow groundwater, indicative of a more vulnerable setting (Litke 2001).

3.4.2.4 Groundwater Use

Groundwater is the primary source for water supply within the region of influence. Uses include irrigation, public water supply, livestock watering, self-supplied industrial, and self-supplied domestic (Figure 3-14).

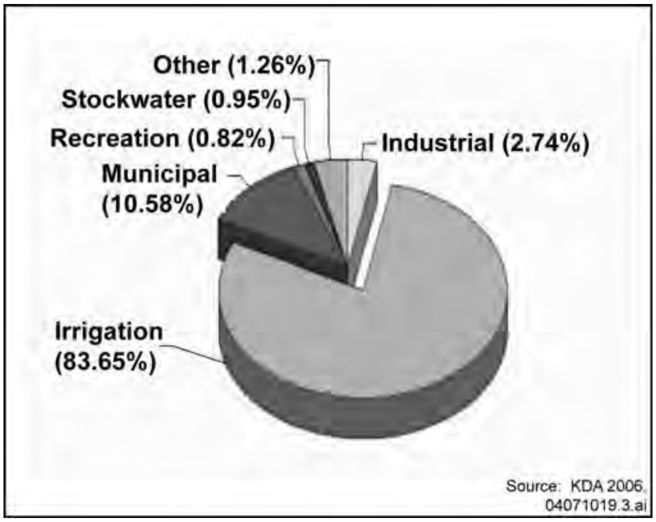

Figure 3-14. Water use in Kansas (based on 2006 water use data).

Figure 3-14 is based on 2006 water use data self-reported by water users with no distinction between groundwater or surface water sources, or specific separation of self-supplied domestic volumes. The largest use of water is for irrigation purposes, followed by municipal and industrial uses. Self-supplied domestic use was estimated to be 0.5 percent of the overall water use in Kansas in 2000 (Kenny and Hansen 2004, Figure 2).

Table 3-6 presents 2007 irrigation water use data for the Kansas counties within the region of influence (KWO et al. 2009). The data provide the general breakdown of acres irrigated, water used, and the ratio of acre-feet of water per acre for various crops including alfalfa, corn, sorghum, wheat, and other or multiple crops. The total volume of water used for irrigation ranged from a high of over 267,000 acre-feet (330 million cubic meters) in Finny County, Kansas, to a low of about 33,000 acre-feet (41 million cubic meters) in Hamilton County. Stevens County had a total irrigation water use of about 211,000 acre-feet (261 million cubic meters) in 2007.

Municipal use of groundwater from the High Plains aquifer in Stevens County was for public water supplies of the cities of Hugoton and Moscow, Kansas. Based on 2007 water use reports, the municipal use in Stevens County was approximately 1,410 acre-feet (1.7 million cubic meters) per year. The City of Hugoton reported use of approximately 1,280 acre-feet (1.5 million cubic meters), and the City of Moscow reported approximately 130 acre-feet (0.2 million cubic meters) used in calendar year 2007 (Ingham 2009).

Table 3-6. 2007 irrigation water use data for Kansas counties within the region of influence.

County	Area irrigated [acres (square kilometers)]	Total reported water use [acre-feet (million cubic meters)]
Finney	227,077 (919)	267,568 (330)
Grant	103,258 (418)	114,319 (141)
Gray	179,289 (726)	197,645 (244)
Hamilton	28,517 (115)	33,342 (41)
Haskell	186,487 (755)	197,741 (244)
Kearny	97,767 (396)	138,177 (170)
Morton	45,774 (185)	41,765 (52)
Seward	124,476 (504)	159,833 (197)
Stanton	109,634 (444)	116,353 (144)
Stevens	174,213 (705)	211,466 (261)

Source: KWO et al. 2009.

3.5 Biological Resources

The biological resources section of this EIS presents known *flora* and *fauna* within a 30-mile (48-kilometer) region of influence. This section characterizes biological resources and identifies flora, fauna, *managed lands*, threatened and endangered species, and other biological resources within the region of influence (Figure 3-15). Biological resources (plants and animals) respond to the physical environment including land use, climate, soils, and hydrology (Sections 3.1, 3.2, 3.3, and 3.4 of this EIS, respectively). Appendix D of this EIS presents the wetland survey for the playa on the 425-acre (1.7-square-kilometer) east buffer area. Section 3.4.1.4 discusses potential wetlands and floodplains.

Impacts to biological resources would be expected to be greatest at the Biorefinery Project site and decrease proportionally as the distance from the Project site increased. Based on the nature of land disturbance associated with implementation of the Proposed Action and Action Alternative and the biomass procurement and storage strategies, this section focuses on the biorefinery construction site and a region of influence of 30 miles (48 kilometers) from the Project site.

The U.S. Fish and Wildlife Service, Kansas Department of Wildlife and Parks, and the Oklahoma Department of Wildlife Conservation enforce laws concerning *listed species*, migratory birds, *critical habitats*, and other biological resources. DOE requested information from these agencies on known threatened and endangered species locations, critical habitats, *high-quality natural areas*, public managed areas, and other biological resources of concern within a 30-mile (48-kilometer) radius of the Biorefinery Project site. The results of the consultations and copies of agency correspondence are included in Appendix G of this EIS.

During the scoping process, the U.S. Fish and Wildlife Service expressed concerns on the potential for impacts to the lesser prairie chicken (*candidate species* being considered for listing as a federal threatened and endangered species) and other bird-nesting habitat. Based on requests from regulatory agencies that have regulatory responsibility for natural resources, DOE evaluated the lesser prairie chicken in detail; specifically, DOE evaluated known range, potential habitat, and potential impacts to the lesser prairie chicken habitat using information provided by and analysis techniques recommended by the U.S. Fish and Wildlife Service, Kansas Department of Wildlife and Parks, and the Oklahoma Department of Wildlife Conservation. Based on the above consultations, the black-tailed prairie dog was also selected as an ecological *indicator species* for the black-footed ferret and burrowing owl and evaluated in greater detail.

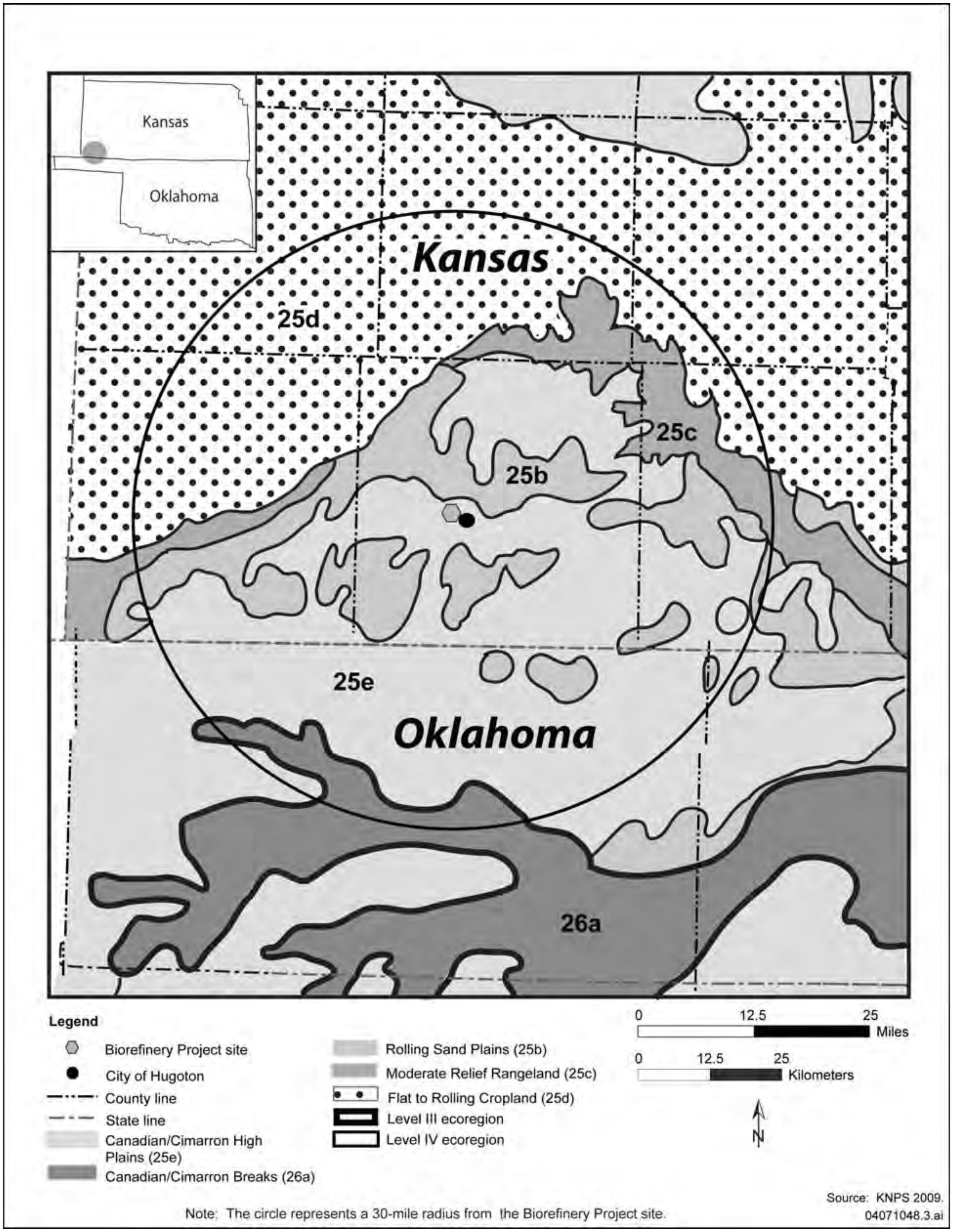

Figure 3-15. Level IV Ecoregions in the 30-mile (48-kilometer) region of influence.

3.5.1 ECOREGIONS

Ecoregions are areas of similar topography, weather patterns, soils, and vegetation. The following Level IV Ecoregions are present in the 30-mile (48-kilometer) region of influence (Figure 3-15) (KNPS 2009):

25b – Rolling Sand Plains

Ecoregion 25b consists of gently undulating to hummocky, sandy plains with sand hills, depressions, and stabilized, partially stabilized, or active sand dunes; predominantly rangeland with irrigated agriculture. Small wetlands are found between dunes where the water table is high. Drainage networks are not well established. There are few perennial streams. Land cover includes grassland, rangeland, and, in suitable areas, irrigated cropland growing grain sorghum. Overgrazed rangeland is common. Cattle winter on sorghum stubble fields and on locally grown feeds. Between-dune wetlands attract migrating shorebirds and waterfowl. Potential natural vegetation includes sand sagebrush-bluestem prairie. On fine sandy loams, blue grama, buffalograss, sand dropseed, and sand bluestem dominate. On loamy fine sands, sand sagebrush, grama, and sand dropseed dominate. On lightly grazed sites, little bluestem is becoming increasingly common. On heavily grazed, sandy sites, sand sagebrush is becoming increasingly common. On stabilized dunes, sand sagebrush, grasses, and skunkbush are found.

25c – Moderate Relief Plains

Ecoregion 25c consists of irregular, rolling to broken, moderately sloping plains. Stream channels are wide, sandy, and usually dry. The area has intermittent streams, with a few large perennial streams. Historically, perennial streams fed by isolated springs may have been more abundant, but water consumption for agriculture and the lowering of the water table have reduced flow and dried up springs and many streams. Land cover includes irrigated farmland, grassland, rangeland, and some small areas of dryland farming. The most-rugged, least-accessible rangelands have a better cover of grasses than less-rugged, more-accessible lands, which typically have been overgrazed by livestock. Potential natural vegetation is a combination of short-grass and mixed-grass prairies. Short-grass prairie (blue grama, sand dropseed, and buffalograss) dominates on upland sites, giving way to mixed-grass prairie (little bluestem, side-oats grama) on slopes, sites along rivers and streams with moderate supplies of moisture, and on sites overlain by thicker loess deposits. Cretaceous chalks, a unique association called the chalkflat prairie, (which is a mixed-grass prairie) is present at a few locations.

25d – Flat to Rolling Cropland

Ecoregion 25d consists of flat to rolling plains with few, mostly intermittent, streams. The area has dryland cropland and irrigated agriculture. Potential natural vegetation in the north includes mixed-grass prairie: needle-and-thread, blue grama, threadleaf sedge, prairie sandreed, and western wheatgrass. Potential natural vegetation in the south includes short-grass prairie: blue-grama, buffalograss, and scattered, isolated sites with alkali sacaton, western wheat grass and “inland” saltgrass.

25e – Canadian/Cimarron High Plains

Ecoregion 25e consists of nearly level, rolling, or hummocky plains of mostly cropland; land too sandy or steep for farming is rangeland. Breaks occur near large streams. Playas are found in scattered depressions; they dry up seasonally or after a series of drought years. Drawdown of the High Plains aquifer has reduced stream flow or caused streams to go dry. Prior to the 20^{th} Century, the perennial stream reaches lost most of their flow in summer, but retained extensive pools; springs contributed to localized flow. Today, channels are often dry, and drainage networks are not well established; there are only a few ephemeral and intermittent streams in wide, shallow, sandy channels. Center pivot irrigation is widely used. Rangeland has been widely overgrazed with a significant amount of bare ground. Playa wetlands are used by migratory waterfowl and other wetland birds as wintering or stopover places. Potential natural vegetation includes short-grass prairie in loess-mantled areas (blue grama and buffalograss dominate) with sand-sage prairie in areas with coarse-textured soils. Native scattered cottonwood with a dense understory composed of shrubby willow are found in riparian areas. At the beginning of the 19th century, blue grama and buffalograss were common, and bluestem, wiregrass, hairy grama, three awn, and side-oats grama occurred locally. Sandy, overgrazed range has been invaded by sand sagebrush. Cottonwoods in some areas have died due to the lowering of the water table.

26a – Canadian/Cimarron Breaks

Ecoregion 26a consists of irregular, dissected slopes, bluffs, and gypsum-capped buttes. Prior to the 20th century, summer flow in perennial reaches was limited, but large, enduring pools occurred. Today, streams are often dry. The Cimarron River has sandy bottoms and low turbidity at base flow. Streams flowing over deposits of the Ogallala Formation have silty mud substrates (with occasional gravel areas) and high turbidity. Land cover includes grassland, rangeland, and some riparian woodland. Recent drawdown of the Ogallala Aquifer has caused many springs to disappear, thereby reducing stream flow and wetland size. Cattle in and near channels has increased downstream turbidity. Potential natural vegetation includes mostly short-grass prairie (blue grama and buffalograss dominate); mixed-grass prairie, dominated by big bluestem (on more mesic sites), little bluestem, side-oats grama, blue grama, and some hairy grama, with eastern red-cedar a dominant tree, especially in sites sheltered from fire. Sand sagebrush-bluestem prairie can be found along the Beaver River. On uplands, short-grass prairie or mixed-grass prairie occur. In riparian areas, cottonwood, hackberry, mulberry, willow, and plum occur.

3.5.2 FLORA

The Biorefinery Project site is adjacent to the city of Hugoton, a historic railroad line, grainery, industrial park, airport, golf course, paved highways, gravel roads, and row-crop agriculture. There are no significant aquatic or native prairie habitats within or adjacent to the Project site. The Project site has been in continuous agricultural use for decades, and all habitats within the Project site have been disturbed by agricultural activities, urban development, road construction, and/or railroad construction (NRCS 2006b; USGS 1974, 1975; EDR 2007a, 2007b).

Native prairie within the 30-mile (48-kilometer) region of influence is located mostly in the Cimarron National Grassland and rough land that is less suitable to grow agricultural crops if privately owned. Prairie land is managed in the Cimarron National Grassland by rotational grazing and some prescribed burning. Management of native habitats is highly variable on private lands. The lesser prairie chicken habitat and black-tailed prairie dog habitat shown on Figure 3-16 corresponds with the locations most likely to have native prairie and/or habitats mostly dominated by native species. Table 3-7 lists common native plant species, exotic/invasive species, and common agricultural crops present within the 30-mile region of influence.

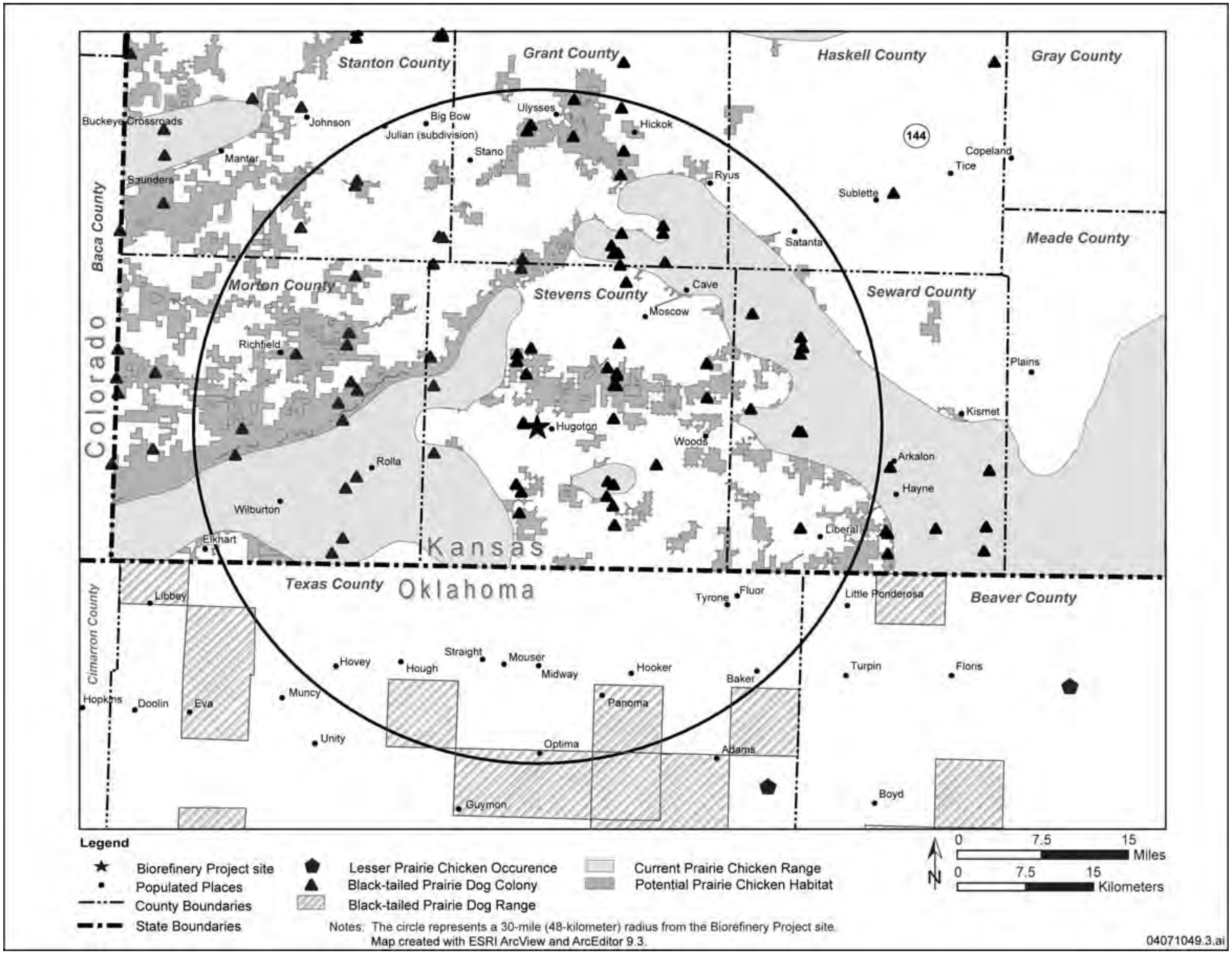

Figure 3-16. Lesser prairie chicken and black-tailed prairie dog habitats.

Table 3-7. Common vegetation within the 30-mile (48-kilometer) region of influence.

Native plant species	Exotic and invasive species
Big bluestem	Tamarisk
Little bluestem	Russian olive
Sand bluestem	Reed canary grass
Western wheatgrass	Fescue
Blue grama	Smooth brome
Hairy grama	Barnyard grass
Buffalo grass	Shattercane
Sideoats grama	Johnson grass
Sand sage	Bindweed
Switchgrass	Yellow sweet clover
Dallisgrass	Japanese brome
Sand lovegrass	Cheatgrass
Goldenrod beggarweed	Russian tumbleweed
Sand dropseed	Alkali weed
Red three-awn	Field bindweed
Andean prairie clover	Horseweed
Buffalo gourd	Musk thistle
Giant evening star	Dalmation toadflax
Plains evening star	Morning glory
Western soapberry	Loco weed
Sandhill goosefoot	Puncture weed
Threadleaf sedge	Cocklebur
Prairie sandreed	Sandhill sage brush (in unmanaged pastures)
Curly dock	
Smartweed	
Inland salt grass	
Yucca	
Prickly pear	
Catclaw	
Skunkbrush	
Plains cottonwood	
Sandbar willow	
Peachleaf willow	
Black willow	
Shin oak	
Winterfat	
Hackberry	
Eastern red cedar	

Note: Noxious weeds from Kansas Statutes Annotated 2-1314.
Sources: Jones and Cushman 2004; NRCS 2006a, 2006b; USFS 2005a, 2005b, 2006a; KNPS 2009.

3.5.3 FAUNA

Fauna includes mammals, resident birds, neotropical migratory birds, reptiles, amphibians, insects, and fish. Table 3-8 lists mammal, bird, reptile, and amphibian species that occur within the 30-mile (48-kilometer) region of influence (Fisher and Gregory 2001; KSGAP 2003; GAP 2008; USFS 2008a). The lesser prairie chicken and black-tailed prairie dog are discussed in detail below. Section 3.5.4 discusses threatened and endangered species.

Table 3-8. Mammal, bird, reptile, and amphibian species that occur within the 30-mile (48-kilometer) region of influence.

Mammals	Birds	Reptiles/amphibians
Badger	Lesser prairie chicken	Plains leopard frog
White-tailed deer	Northern bobwhite	Checkered garter snake
Mule deer	Rio Grande wild turkey	Longnose snake
Elk (CNG, re-introduced 1981)	Mourning dove[a]	Western rattlesnake
Coyote	Ring-necked pheasant	Greater short-horned lizard
Black-tailed prairie dog	Eastern screech owl	Ornate box turtle
Raccoon	Long-billed curlew	Hognose snake
Striped skunk	Cassin's sparrow	
Black-tailed jackrabbit	Field sparrow	
Cottontail rabbit	Scaled quail	
Fox squirrel	Kill deer	
Gray squirrel	Canada goose	
Opossum	Red-winged blackbird[a]	
Pronghorn antelope (north of Cimarron in CNG)	Western Meadowlark[a]	
	Burrowing owl[a]	
Mole	Ferruginous hawk[a]	
Deer mice	Grasshopper sparrow[a]	
Shrew	Brewer's sparrow[a]	
Swift fox	Loggerhead shrike[a]	
Thirteen-lined ground squirrel	Mountain plover[a]	
	Yellow-billed cuckoo[a]	
	Horned lark	
	Swainson's hawk[a]	
	Dickcissel[a]	

Sources: USFWS n.d.a; Jones and Cushman 2004; USFS 2005c.
a. Neotropical migrants (ABC 2008).
CNG = Cimarron National Grassland.

The 2006 Kansas Department of Wildlife and Parks Stream Monitoring and Assessment Program *Sub-Watershed Report* (KDWP 2006a) included results of fish and aquatic species sampling at 11 locations along the Cimarron River. Sampling was completed from 1999 to 2004. There were sample locations within the Cimarron National Grassland in southwest Morton County in the west-central portion of the region of influence, in Seward County after the main branch and North Fork of the Cimarron River merge in the northeast portion of the region of influence, and in the southwest corner of Meade County approximately 45 miles (72 kilometers) east-southeast of Hugoton. Up to 13 species of aquatic insects were noted at individual sample locations; no mussels were noted at any of the sample locations.

The Wildlife and Parks Department assessments were based on an index for biological integrity developed by Region 7 of the EPA, a macro-invertebrate index based on water quality tolerances of species noted during surveys, and assessment of water quality data such as water temperature, turbidity, dissolved oxygen, pH, chlorides, ammonia, nitrates, and phosphorus. These assessments concluded that, in general, the portions of the Cimarron River located within the region of influence were moderately to highly impacted by nutrient- and oxygen-demanding pollutants.

Table 3-9 lists the fish species noted within the region of influence during the Cimarron River surveys.

Table 3-9. Fish species within the region of influence.

Fish species
Largemouth bass
Red shiner
Sand shiner
Fathead minnow
Plains minor (state SINC)
Bluegill
Central stoneroller
Red River pupfish
Green sunfish
Common carp (exotic/invasive)
Black bullhead
Emerald shiner
Plains killfish
Suckermouth minnow
Yellow bullhead
Channel catfish
Arkansas darter (state threatened)
Western mosquitofish

Sources: KDWP 2006a, USFS 2006b
SINC = species in need of conservation.

The 2006 to 2008 *Rural Mail Carrier Survey* reports published by the Kansas Department of Wildlife and Parks (Pittman 2007, 2008a, 2008b) indicate turkeys are increasing in abundance in the southwestern part of Kansas and that other hunted species populations are stable. Table 3-10 lists the hunted wildlife occurring in the region of influence.

Table 3-10. Hunted wildlife occurring in the region of influence.

Hunted species
Lesser prairie chicken
Ring-necked pheasant
Mourning dove
Northern bobwhite
Rio Grande wild turkey
Cottontail rabbit
Black-tailed jack rabbit
Gray squirrel
Fox squirrel
Mule deer
White-tailed deer

3.5.3.1 Lesser Prairie Chicken

The lesser prairie chicken is a resident ground-nesting member of the grouse family that is from 15 to 16 inches (38 to 41 centimeters) long and weighs from 22 to 28 ounces (0.62 to 0.79 kilograms). Adults eat insects, seeds, leaves, buds, and cultivated grains. Juveniles eat primarily grasshoppers and beetles. The prairie chicken needs a variety of habitats within a home range of approximately 520 to 1,225 acres (2.10 to 4.96 square kilometers). Males have a high fidelity to breeding and display grounds called *leks*. Leks are usually located in higher topographic positions with good visibility. The males spar or fight with other males from late February to early May, call or "gobble" and "boom" to attract females, and then display and mate with females through April. Display includes inflating orange sacs under their checks, lifting their tail, erecting their neck plumes that look like pointed ears, and slight spreading of the wings. Females lay 10 to 14 eggs and incubation lasts 23 to 26 days.

Suitable lesser prairie chicken habitat types includes the following: sandsage shrubland, tallgrass prairie, sand prairie, western wheatgrass, sandstone glade/prairie, mixed prairie, and shortgrass prairie; and CRP grasslands within 1 mile (1.6 kilometer) of the previously mentioned habitats. CRP lands with a mixture of native grasses, legumes, and wildflowers are preferred over CRP lands with *monocultures* of introduced grasses. Sand dropseed, side oats grama, three-awn, blue grama, little bluestem, sand bluestem, and shinnery oak are common species found in lesser prairie chicken habitats. Figure 3-16 shows potential habitats and the current range of the lesser prairie chicken within the region of influence. Areas that are avoided by the lesser prairie chicken include upland and riparian woodlands, urban areas, lands within 0.25 mile (0.40 kilometer) of developed roads and power lines, and areas within 1 mile of tall, manmade structures and wind farms. The lesser prairie chicken prefers areas with less than 10 percent overall coverage of agricultural lands that are tilled, mowed in the spring, and/or continuously overgrazed (Hagen and Giesen 2005; NSE 2008; USFWS n.d.b, n.d.c). The following describes habitat components that the lesser prairie chicken requires:

- Nesting cover (April 15 to June 15). Native prairie or other grasslands, including CRP and hay meadows, that provide residual cover in spring greater than 10 inches (25 centimeters) and less than 30 inches (76 centimeters) in height with ground-level openings. Vegetation should be clumpy with abundant bunchgrass. Heights should be variable across pastures with some areas grazed noticeably more and others noticeably less than average. Trees should be absent or minimal. Trees should be restricted to low areas such as drainages.

- Brood-rearing cover (May 15 to July 31). Herbaceous cover in native pastures that provides overhead cover and ground-level openings for chicks. Vegetation greater than 10 inches (25 centimeters) and less than 30 inches (76 centimeters) in height with abundant forbs such as alfalfa.

- Winter cover. Extensive native prairie or other grassland, including CRP, that provides residual cover greater than 14 inches (36 centimeters) and less than 30 inches (76 centimeters) in height with ground-level openings for ease of movement.

- Food. Abundant forbs attract insects for chicks and adults. Small amounts of green vegetation are consumed throughout the year. Seeds provided in grain stubble and produced by perennial and annual weeds provide a fall and winter food source.

- Water. Adequate moisture is generally obtained in foods eaten or from dew. Open water may be used if available during drought conditions in semiarid [less than 25 inches (64 centimeters) annually] parts of the state.

- Interspersion. Areas of nesting cover and brood-rearing cover must be present in close proximity to each other. Edges between burned and unburned areas are highly valuable for reproduction. Areas dominated by annual burns offer very little nesting habitat. Areas with insufficient burning limit brood habitat and are vulnerable to tree invasion.

The Kansas Department of Wildlife and Parks currently allows hunting of the lesser prairie chicken (KDWP 2006b). The 2008 season ran from November 15 to December 31, with a daily limit of one. The *2008 Kansas Small Game Report* (Pittman 2008c) and *2006 Small Game Hunter Activity Survey* (Rodgers 2007a) estimated that from 1998 to 2006, approximately 100 to 520 lesser prairie chickens were harvested by hunters each year in Kansas. The smallest harvests in the past 30 years were in 1996, 1999, and 2000. The largest hunter harvests of the lesser prairie chicken in the past 30 years occurred in 1979, 1982, and 1983, with the largest estimated harvest of 6,200 birds occurring in 1982.

The 2005, 2006, and 2007 *Rural Mail Carrier Surveys* indicated that lesser prairie chicken populations were currently stable within an approximately 25-county area in the southwestern corner of Kansas (Pittman 2007, 2008a, 2008b). The Wildlife and Parks Department prairie chicken surveys noted leks in Finney, Hamilton, Meade, and Morton counties in 2006 and 2007 (Rodgers 2007b, 2008).

The historically occupied range of the lesser prairie chicken has decreased by 92 percent from late 1800s to present due to conversion of prairies to farmland and overgrazing (USFS 2008b). There are significant populations found in the Cimarron National Grassland mostly south of the Cimarron River. An estimated 61,638 acres (29 square kilometers) of potential lesser prairie chicken habitat are present in the Cimarron National Grassland. Range sites typically used by the lesser prairie chicken include sandy plains, choppy sand, deep sand, gravelly breaks, dry creek beds, and sandy bottomland.

3.5.3.2 Black-Tailed Prairie Dog

The black-tailed prairie dog is a *diurnal*, burrowing rodent up to 15 inches (38 centimeters) in length, weighs up to 3 pounds (1.4 kilograms), is yellowish-buff in color, has a 2-inch (5-centimeter) black-tipped tail, and lives in colonies or towns. Figure 3-16 shows black-tailed prairie dog colonies from aerial surveys conducted in 2000. The prairie dog is an herbivore that eats a variety of vegetation including buffalo grass and blue grama. Prairie dogs typically inhabit about 20 percent of available or potential habitat at any one time. Over time, colonies tend to move or migrate to different portions of the available habitat. The black-tailed prairie dog generally prefers natural habitats in loams and fine-textured soils. Prairie dog populations have declined primarily due to the widespread conversion of native prairie to cropland, eradication efforts, and the introduction of sylvatic plague. The plague primarily affects rodents and was first observed in California in 1908 and has since spread eastward.

There are rare and endangered species that are associated with black-tailed prairie dog colonies. The black-footed ferret is recognized by the State of Kansas and the federal government as an endangered species and preys almost exclusively on the black-tailed prairie dog. Burrowing owls use black-tailed prairie dog burrows. The prairie dog is an important prey species for the swift fox and ferruginous hawk. The closely cropped vegetation around prairie dog colonies is a preferred nesting habitat for the mountain plover.

The black-tailed prairie dog was removed from the U.S. Fish and Wildlife Service candidate species list in 2004. The black-tailed prairie dog is currently a huntable species in Kansas and a state hunting license is required. The season is year-round and there are no bag limits. On December 2, 2008, the U.S. Fish and Wildlife Service published in the *Federal Register* a “90-Day Finding on a Petition to List the Black-tailed Prairie Dog as Threatened or Endangered” (73 FR 73211).

3.5.4 THREATENED AND ENDANGERED SPECIES

DOE reviewed published information on listed threatened and endangered species for Stevens County. DOE used the U.S. Fish and Wildlife Service Critical Habitat mapper to search for critical habitat or known locations of threatened and endangered species as well as federal- and/or state-managed lands (USFWS n.d.b, n.d.d). No known threatened and endangered species locations, critical habitat, or state/federal-managed lands were noted within or adjacent to the Biorefinery Project site. The USGS topographical maps (USGS 1974, 1975) and NRCS soil survey (NRCS 2006b) did not indicate the presence of federal or state lands managed within or adjacent to the Project site.

A review of the Kansas Department of Wildlife and Parks Web site indicated the potential historic presence of 11 threatened and endangered species and 7 *species in need of conservation* in Stevens County (KDWP 2005a, 2005b, 2005c, 2005d, 2005e, 2005f). DOE reviewed the range maps and habitat descriptions for all 18 species listed for Stevens County. Habitats for the 18 species of concern included streams, rivers, lakes, relatively large natural wetlands and marshes, sand bars, relatively large areas of native prairie, riparian forest, rocky areas or outcrops, and canyons; these types of habitats are not present within the Biorefinery Project site. Most of the species are intolerant of frequent human disturbance. Table 3-11 shows threatened and endangered species and critical habitat for the 30-mile (48-kilometer) region of influence. Table 3-12 lists species in need of conservation that have been noted within the 30-mile region of influence.

Table 3-11. Threatened and endangered species within the 30-mile (48-kilometer) region of influence.

Common Name	Scientific name	State list	Federal list	Critical habitat (county)
Arkansas darter	*Etheostoma cragini*	T	C	Seward
Arkansas River shiner	*Notropis giraridi*	E	T	Grant, Morton, Seward, Stevens
Flathead chub	*Platygobio gracilis*	T	-	No
Green toad[a]	*Bufo debilis*	T	-	Morton
Checkered garter snake	*Thamnophis marcianus*	T	-	No
Longnose snake	*Rhinocheilus lecontei*	T	-	No
Texas blind snake	*Leptotyphlops dulcis*	T	-	No
Black-footed ferret	*Mustela nigripes*	E	E	No
Eastern spotted skunk	*Spilogale putorius*	T	-	No
Bald eagle	*Haliaeetus leucocephalus*	T	D	No
Peregrine falcon	*Falco peregrinus*	E	-	No
Least tern	*Sterna antillarum*	E	E	No
Piping plover	*Charadrius melodus*	T	T	No
Snowy plover	*Charadrius alexandrinus*	T	-	No
Whooping crane	*Grus americana*	E	E	No
Lesser prairie chicken	*Tympanuchus pallidicincfus*	-	C	No

Sources: USFWS 2008; KDWP 2005a, 2005b, 2005c, 2005d, 2005e, 2005f; OBS 2001.
a. Pre-Dust Bowl records in Morton County only.
C = candidate species.
D = delisted.
E = endangered.
T = threatened.

Table 3-12. Species in need of conservation within the 30-mile (48-kilometer) region of influence.

Species
Plains minnow
Black tern[a]
Bobolink[a]
Mountain plover[a]
Ferruginous hawk[a]
Chihuahuan raven
Curve-billed thrasher
Long-billed curlew
Ladder-backed woodpecker
Golden eagle
Short-eared owl[a]
Red-spotted toad
Western hognose snake
Eastern hognose snake
Glossy snake
Channel catfish
Arkansas darter (state threatened)
Western mosquito fish

Sources: USFWS 2008; USFS 2008c.
a. Neotropical migratory bird (ABC 2008).

The bald eagle prefers large bodies of water with nearby large trees with lateral branches. Large water bodies are absent within a 1-mile (1.6-kilometer) radius of the Biorefinery Project site. The eastern spotted skunk, flathead chub, least tern, longnose snake, peregrine falcon, piping plover, snowy plover, and Texas blind snake were listed only as "probable historic range." The species in need of conservation list included black tern, Chihuahuan raven, ferruginous hawk, golden eagle, long-billed curlew, plains minnow, and yellow-throated warbler, all of which were listed as "known current range" for Stevens County, but were present in habitats that did not occur within 1 mile of the Project site. Most of the species in need of conservation were part-year residents with no nesting in Stevens County noted.

3.5.5 MANAGED LANDS AND CIMARRON RIVER

The majority of the listed species, neotropical migrants, native prairie, and other biological resources of concern are present in and adjacent to the Cimarron National Grassland, and/or associated with the Cimarron River and its riparian corridor.

3.5.5.1 Cimarron National Grassland

The U.S. Forest Service manages the Cimarron National Grassland. The majority of the Grassland was acquired during or shortly after the Great Depression and Dust Bowl in the 1930s. Recreational facilities include blinds to observe lesser prairie chicken leks during the mating season, hiking trails, horseback riding, camping, hunting, and fishing. In addition, the grassland is divided into 30 allotments for livestock grazing (USFS 2005d). Currently, the Morton County Grazing Association has the only livestock-grazing permit on the Cimarron National Grassland. There are approximately 400 oil and gas wells on the National Grassland, and approximately 125 windmills are used to pump water for livestock watering. There are approximately 500 miles (800 kilometers) of fence that are maintained by the Morton County Grazing Association (USFS 2008b).

The vegetation condition is manipulated through the use of livestock grazing. Prescribed fire is also used to improve the health of the rangelands (USFS n.d.). On average, approximately 5,000 to 5,300 heads of cattle graze on the grassland during the grazing season of May 1 through October 31. A deferred grazing system is used in upland areas and a rest-rotation system is used along the Cimarron River and riparian areas. Each of the grazing allotments has livestock stocking rates based on the precipitation received the previous year.

Approximately 60 percent of the Cimarron National Grassland is sandsage prairie, 30 percent is shortgrass prairie, and 10 percent is found along the Cimarron River floodplain and riparian corridor. The sandsage prairie is mostly in poor condition; the dominant species include sand sagebrush, sand dropseed, sand lovegrass, and big bluestem. The shortgrass prairie is a mixture of poor, fair, and good quality habitats; the dominant species include blue grama and buffalograss. The Cimarron corridor is in mostly poor condition and dominants include sand bluestem, little bluestem, needle and thread, western wheatgrass, and sand lovegrass. On private lands there are approximately 33,000 acres (130 square kilometers) of CRP lands adjacent to sandsage prairie areas in the Cimarron National Grassland and approximately 19,000 acres (77 square kilometers) of CRP lands adjacent to shortgrass prairies in the Cimarron National Grassland. Lesser prairie chicken surveys have noted birds in all areas south of the Cimarron River. Populations have recently varied from approximately 175 to 285 birds, and 44 lesser prairie chicken leks have been identified within the National Grassland.

3.5.5.2 Cimarron River

As recently as the mid-1940s, reaches of the Cimarron River were perennial in what is now the Cimarron National Grassland and in the southern portions of Grant County, Kansas. The portions of the Cimarron River that ran through Stevens County and the northwest part of Seward County were intermittent. Water level declines in the High Plains aquifer due to pumping of irrigation water have since eliminated groundwater discharges to the Cimarron River within the region of influence.

The Cimarron River currently has ephemeral and intermittent flows within the region of influence. Approximately 15 miles of perennial stream flow have been lost just outside of the region of influence in southeast Seward County from 1900 to present (Young et al. 2005). High-quality habitat for the Arkansas darter is not likely to exist on the Cimarron National Grassland because of the loss of connectivity with the main stem of the Cimarron River due to historical removal of groundwater for irrigation (USFS 2005e). Portions of the Cimarron River, North Fork of Cimarron River, and unnamed tributaries of the Cimarron in Morton, Grant, Stevens, and Seward counties have the following designations (USFS 2007):

- Exceptional State Waters (Seward, Stevens)
- Special Aquatic Life Use Waters (Seward, Stevens)
- Outstanding National Resource Waters (Morton, Stevens)

3.6 Utilities, Energy, and Materials

This section describes the current characteristics of the utilities and energy resources and the market for materials in the region of the Biorefinery Project site. The region of influence considered for utilities, energy, and materials is the public and private resources from which the Proposed Action and Action Alternative would draw. These resources are described, as applicable, on a regional basis (for example, for the electrical grid, interstate natural gas pipelines, and market for most building materials) or a local basis (for example, for drinking water and sewer services in Hugoton). Each of the topic discussions in this section includes a description of the region of influence being considered for that resource.

In general terms, the utilities are those traditionally provided by communities to their residents and businesses. The utilities addressed in this section are the water, sewer, and sanitation services (that is, *solid waste* pick-up and disposal) provided by the City of Hugoton. The energy resources described in this section similarly include those sources of *marketed energy resources* that would be used by construction and operation of the biorefinery and by the increased population associated with the biorefinery. The marketed energy resources characterized in this section include electricity and natural gas. Other *fossil fuels* and petroleum products (such as gasoline and lubricants), whose availability could be affected, are also described in this section, even though in some instances they may not be used for their energy content. Materials described in this section are limited to those that would be involved in the construction of the biorefinery. Process-related *chemicals* (other than petroleum products) that would be consumed during operations of the biorefinery are addressed as hazardous materials in Section 3.7 of this EIS. Feedstock materials that would be processed in the facility are addressed as part of land use discussions in Section 3.1.

3.6.1 UTILITIES

This section describes the water, sewer, and sanitary waste services provided by the City of Hugoton. The region of influence is limited to Hugoton as a conservative approach to evaluate potential impacts on utilities. As noted in the evaluation of socioeconomic impacts (Section 4.9.1.2), it is not feasible to predict residential distribution patterns for workers and families that would in-migrate to the general four-county area to support the construction and operation of the biorefinery. Since there is no means to identify precisely where new population would reside, it will be assumed, solely for the evaluation of impacts to utilities, that population growth would be focused on the Hugoton area. It is reasoned that spreading the population out over a larger area, and particularly to include the larger communities of Liberal, Kansas, and Guymon, Oklahoma, would act to reduce impacts to utilities in any single community. Conversely, placing the new population at Hugoton would tend to magnify potential impacts.

The utilities described in this section are defined by the extent of the Hugoton water distribution and sewage collection systems and, in the case of solid waste, the location of the site where the waste would be disposed of. The region of influence is limited to the city of Hugoton and the nearby disposal locations (for sewage and solid waste) because the water, sewer, and sanitary waste utilities are confined to those areas and any direct or indirect impacts would occur therein.

3.6.1.1 Water

The City of Hugoton provides drinking water to its residents and businesses from six wells located within and around the city (Hugoton 2009). The water is treated to remove contaminants and disinfected (Hugoton 2008). The drinking water distribution system includes three storage tanks with a combined capacity of 1.5 million gallons (5,700 cubic meters). These tanks include a 500,000-gallon (1,900-cubic meter) underground storage tank on the north end of town, a 250,000-gallon (950-cubic-meter) tank located in the downtown area, and a 750,000-gallon (2,800-cubic-meter) elevated tank (Hugoton 2009). The distribution system includes water mains located throughout the city [mostly 8- and 6-inch (20- and

15-centimeter) mains in the residential areas] and a 12-inch (30-centimeter) main that runs west from the main portion of the city along US-56. This line has a branch that runs north along Road 11 (the road running north-to-south between the biorefinery and the buffer areas) and another branch that runs north on Road 10 (the road running north-to-south on the west side of the Project site). The branch on Road 11 ends before the railroad, but the branch on Road 10 extends to the half section line where a city water production well is located (Thomas 2008).

In a water quality report for 2007 (Hugoton 2008), the City of Hugoton reported that the city's drinking water was safe and that there were no violations of federal (40 CFR Part 141) or State [Kansas Administrative Regulation (K.A.R.) 28-15a] drinking water standards in 2007.

Potable water usage in the western quarter of Kansas averaged 252 gallons (954 liters) per capita per day over the 5-year period from 2003 through 2007 (KWO 2009c). The City of Hugoton averaged 302 gallons (1,140 liters) per capita per day over that same period (KWO 2009c). With a population of about 3,400 people, this equates to an average water consumption rate for the entire city about 710 gallons (2,700 liters) per minute. The amount of water the City can pump into its distribution system is limited by its water appropriations from the Kansas Department of Agriculture, Division of Water Resources, which is set based on the number of residents served. For 2008, City of Hugoton representatives put water consumption at about 100 million gallons (378,000 cubic meters) less than its groundwater appropriation allowed and have indicated that this volume of water represents a reasonable estimate of its current excess capacity (Thomas 2008). Over an entire year, this excess volume equates to an average excess of 190 gallons (720 liters) per minute. The City representative also noted, however, that any additional population in the future would provide a basis for the City to obtain additional water appropriations.

3.6.1.2 Sewer

The City of Hugoton operates and maintains approximately 16 miles (26 kilometers) of sewer collection mains and three lift stations that make up its sewage collection system. The City's wastewater treatment facilities consist of three treatment lagoons located on the northeast outskirts of the town (Hugoton 2006a). These lagoons were constructed in 2005. According to a City representative, the treatment lagoons were designed to accommodate a population of 4,000 and an average sewage inflow of 320,000 gallons (1,200 cubic meters) per day. The first two ponds are the treatment cells and have a combined capacity of 46 million gallons (174,000 cubic meters). At the average design flow, these two ponds have a holding time of 144 days. The third pond takes overflow from the first two and has a capacity of 13.8 million gallons (52,200 cubic meters), representing another 43 days of holding time (Banker 2008). Treated water in the third pond is used for irrigation. The wastewater treatment lagoons are operated under a Kansas Water Pollution Control Permit issued by the Kansas Department of Health and Environment.

3.6.1.3 Sanitation Services

The City of Hugoton's solid waste collection service routinely picks up waste within the city and takes it to the Stevens County landfill, which is located on the northeast outskirts of Hugoton (near the sewage treatment lagoons). There is adequate land at the present location to allow the landfill to expand an additional 50 acres (0.20 square kilometer), and the 2008 permit renewal form for this landfill indicated the estimated remaining life of the landfill is 119 years (KDHE 2008c) based on an average waste disposal rate of 4,600 tons (4,200 metric tons) per year. Other landfills in the region are described in Section 3.7.1, including the landfill in Grant County, directly north of Stevens County, which is permitted only for construction debris.

The Stevens County landfill has a permit to operate under an exemption from specific design and groundwater monitoring requirements. To qualify for this exemption, the landfill is meeting 40 CFR Part 258 qualifications: (1) the landfill is considered a small *municipal solid waste landfill*, receiving 20 tons (18 metric tons) or less of solid waste per day (annual average); (2) the landfill exhibits no evidence of groundwater contamination; (3) the community has no practicable waste management alternative to the landfill; and (4) the landfill is located in an area with annual precipitation of 25 inches (64 centimeters) or less.

According to records maintained by the Kansas Bureau of Waste Management, the Stevens County landfill received from 11 to 13 tons (10 to 12 metric tons) per day (annual average) during the four years from 2004 through 2007 (BWM n.d.). However, the daily average increased slightly during each of those successive years, and during 2008, the landfill received an average of about 20 tons (18 metric tons) per day (BWM n.d.). The high average for 2008 was attributed to an unusually high quantity of waste deposited at the landfill during the third quarter (that is, July through September) of the year. The volume reported for the third quarter of 2008 was more than double that of any quarter during the preceding 4.5 years. According to a Stevens County representative, the high quantity of waste was attributed to the receipt of about 2,500 tons (2,300 metric tons) of contaminated soil in the month of September 2008. A portion of the contaminated soil from this same event was disposed of in subsequent months, but it was a small amount. The County representative felt this should not be considered a recurring waste stream and that it was not representative of normal operations (Leonard and Olivier 2008). Without the 2,500 tons of nonrecurring waste, the landfill received an average of 13.3 tons (12.1 metric tons) per day during 2008, which is much more in line with the preceding 4 years of record.

3.6.2 ENERGY

This section describes the sources for the electrical power and natural gas in Hugoton and the general area around Hugoton. The section also describes the general availability and sources of other fossil fuels and petroleum products in the general area of Hugoton. The region of influence is defined by the extent of the distribution system for each of these energy resources because they are the elements of the existing environment that could be affected by the Proposed Action and Action Alternative.

3.6.2.1 Electrical Power

The City of Hugoton is interconnected with and generally purchases electricity from Pioneer Electric Cooperative, Inc. of Ulysses Kansas, but also has the capability to produce its own electricity at times when it cannot purchase all of its electricity (Hugoton 2006b). The City's power production capabilities are in the form of seven engine-generator combinations located at its Plant #2 facility and an eighth engine-generator located at the City's Plant #1. According to the engine-generator nameplate data, Plant #2 has a combined rated capacity of approximately 20 megawatts, and Plant #1 adds another 1.4 megawatts. The City's electric distribution department maintains the electric lines and transformers within the city (Hugoton 2006c).

Pioneer Electric Cooperative is the primary electricity provider within Stevens, Morton, Stanton, Grant, and Haskell counties and portions of adjacent counties in the southwest corner of Kansas. This cooperative is a distributor of electrical power in the area and is a co-owner of an electric power-producing corporation. Pioneer Electric serves approximately 15,700 metered customers in 10 counties and owns and maintains more than 215 miles (346 kilometers) of transmission lines (high voltage), 3,400 miles (5,500 kilometers) of distribution line (low voltage), and 19 substations (Pioneer n.d.). A Pioneer Electric 115-kilovolt transmission line runs east-west about 1 mile (1.6 kilometers) north of the Biorefinery Project site, then turns to the northeast (Roach 2009b) (Figure 3-17). One of the substations operated by Pioneer Electric is located just over 1 mile (1.6 kilometers) north of the Project site (Roach 2009c). All of Pioneer Electric electricity is generated in Holcomb, Kansas, at the power station operated by the Sunflower Electric Power Corporation, which is owned by Pioneer Electric and five other Kansas electric cooperatives (Pioneer n.d.).

The Sunflower Electric Power Corporation, a consumer-owned, nonprofit corporation, and the Mid-Kansas Electric Company serves 55 central and western Kansas counties by providing power from 11 power plants to a network that consists of 76 substations and approximately 2,300 miles (3,700 kilometers) of transmission (high voltage) lines (Sunflower n.d.). Sunflower Electric operates and manages Mid-Kansas Electric's facilities and equipment; both companies are owned by the same six Kansas electric cooperatives. The combined net power production and contracted capacity of the two companies is almost 1,300 megawatts, with the largest owned power plant being Sunflower's 360-megawatt coal-fired plant at Holcomb, Kansas (Sunflower n.d.). Sunflower proposed a major expansion to the Holcomb Station, which would add two additional coal-fired units to the facility, each with a generating capacity of 700 megawatts. The Kansas Department of Health and Environment originally denied the air permit for this proposed action (KDHE 2007b), but in May 2009, Sunflower and the State reached a compromise that would allow the Holcomb expansion to move forward with the construction of a single 895-megawatt coal-fired plant (Sunflower 2009). If constructed, this new unit would be partially owned by Sunflower, and a portion of the added generation capacity would be obligated to the Sunflower distribution system.

Sunflower and Mid-Kansas are connected to the regional grid, which provides additional reliability and allows excess energy to be supplied (sold) to other utilities in the region. Sunflower and Mid-Kansas are members of the Southwest Power Pool region under the North American Electric Reliability Corporation (formerly the North American Electric Reliability Council). The Southwest Power Pool covers a region that includes all of Kansas, most of Oklahoma, and parts of Texas, Missouri, Arkansas, and Louisiana.

NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

The North American Electric Reliability Corporation is an independent organization, authorized by federal legislation to develop and enforce standards to ensure the reliability of electrical service in North America (NERC n.d.). The Corporation also monitors and assesses the adequacy of the electric power system in the United States, Canada, and part of Mexico. The Corporation has divided its area of interest into nine regions based on service areas of the electric utilities, and these regional designations are routinely used by various groups and agencies in compiling data and reporting on the country's electrical distribution system.

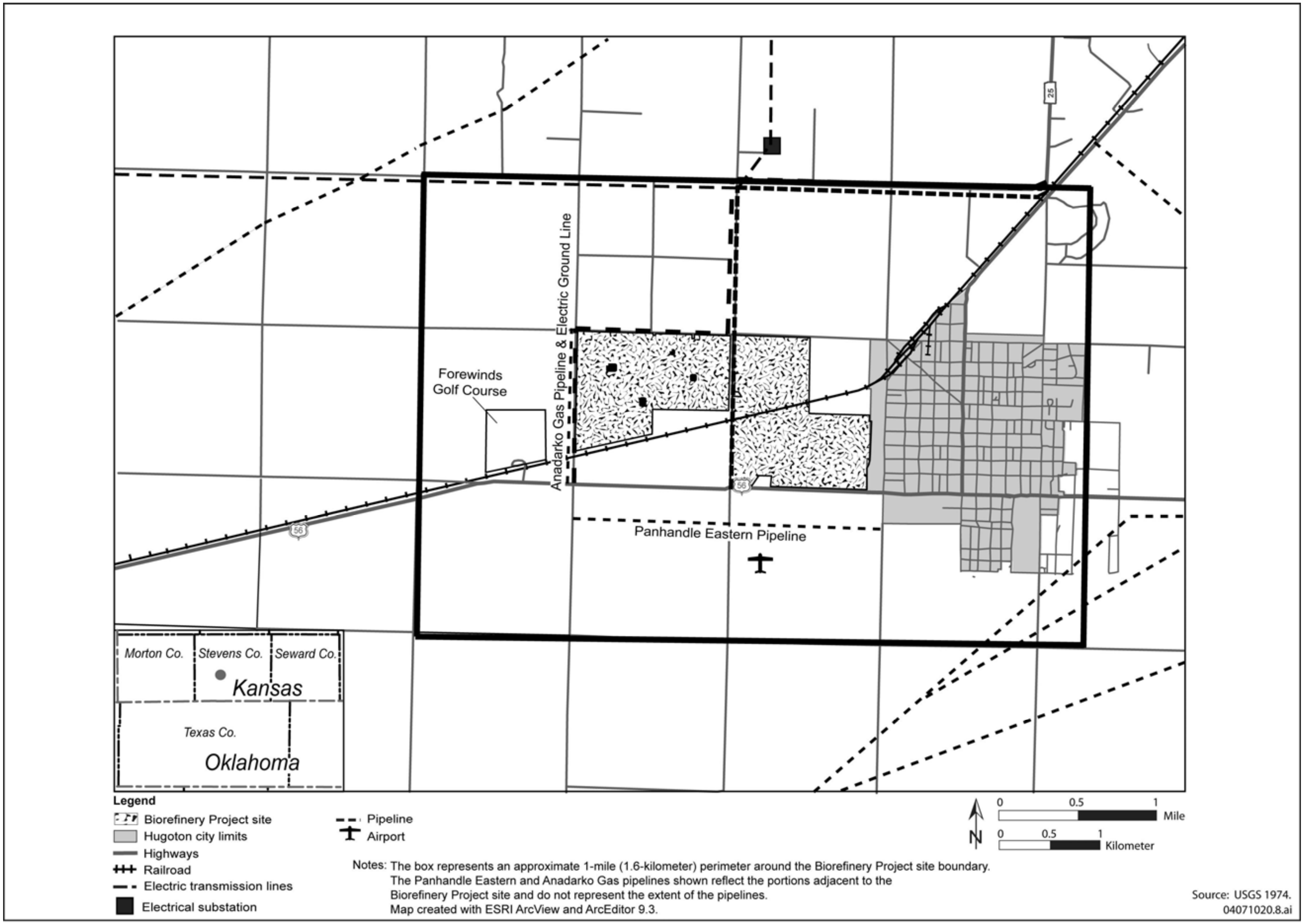

Figure 3-17. Electric and natural gas lines in the area of the Biorefinery Project site.

In its report, *Electric Power Annual 2007* (DOE 2009a), DOE compiled information on electric usage by North American Electric Reliability Corporation regions within the United States. During summer, from 1996 through 2007, the Southwest Power Pool region (which includes Kansas) had net internal electrical demands that averaged 41,000 megawatts and, during the same period, had *capacity margins* that ranged from 9.2 to 18.9 percent (DOE 2009a). (Capacity margin is defined as the amount of unused available capacity of an electric power system at peak load as a percentage of capacity resources.) In projecting future effects of actual and planned capacity resources, DOE estimates that summer net demands in the Southwest Power Pool region from 2007 through 2012 will average 45,100 megawatts, and the capacity margin will range from 14.1 to 15.9 percent (DOE 2009a). During the corresponding winters (extending into 2013), DOE estimates the average net demand will be 33,100 megawatts with the capacity margin ranging from 35.8 to 38.3 percent (DOE 2009a). The significantly lower demand in the winter is consistent with the region's predominant use of natural gas for heating.

3.6.2.2 Natural Gas

The Anadarko Shelf, located in the panhandles of Texas and Oklahoma and extending into Kansas, contains the Hugoton Gas Area, which is the fourth largest natural gas field in the United States (DOE 2009b). As a result, Kansas produces large quantities of natural gas and has a substantial infrastructure for storing and transporting supplies of natural gas throughout the country. In 2007, about 370,000 million cubic feet (10,500 million cubic meters) of natural gas were produced in Kansas and sold, and in December 2008 there were about 260,000 million cubic feet (7,400 million cubic meters) of natural gas in underground storage in Kansas. These two quantities represent 1.8 percent and 3.7 percent, respectively, of the quantities of natural gas marketed and stored within the United States. Kansas typically uses about 60 percent of its natural gas output and transports the excess to other parts of the country. About half of the natural gas used in the state is consumed by the industrial sector. Residential users represent the next largest consumer group at about one quarter of the total use; commercial users and electric power producers are the consumer groups responsible for the rest of the natural gas consumption (DOE 2009c). Nearly three quarters of Kansas residents use natural gas as their primary energy source for home heating. In 2007, the total quantity of natural gas used in the state was about 286,000 million cubic feet (8,100 million cubic meters), which represented 1.2 percent of the total national consumption (DOE 2009b).

One of United States' major natural gas pipeline corridors originates in southwest Texas and extends to the Chicago area market. It passes through the gas production fields in the Oklahoma panhandle and southwest Kansas (the Hugoton Gas Area) and links with another pipeline corridor from the Rocky Mountain area and with a corridor from Canada before reaching the Chicago area. There are four major interstate pipelines in the corridor as it passes through the Oklahoma panhandle and southwest Kansas. These major pipelines are owned and operated by the ANR Pipeline Company, Panhandle Eastern Pipeline Company, Northern Natural Gas Company, and Natural Gas Pipeline Company of America (DOE 2009d).

In the local area of Hugoton, Black Hills Energy is the natural gas supplier. Aquila, the former supplier of natural gas in the area, had its natural gas utility assets and related operations in the state of Kansas acquired by Black Hills Energy in early 2008 (BHC 2008).

There are two natural gas pipelines in the immediate area of the Biorefinery Project site (Figure 3-17). One, the Anadarko Gas Pipeline, runs north-south on the western edge of the Project site. The other, the

Panhandle Eastern Pipeline, is one of the four major interstate pipelines passing through the region (as described above) and runs east-west within 1 mile (1.6 kilometers) of the Project site.

3.6.2.3 Other Fossil Fuels and Petroleum Products

Kansas contributes about 2 percent of the crude oil produced in the United States, putting it in the top 10 oil-producing states in the country (DOE 2009b). Crude-oil production takes place throughout the state, and a network of pipelines delivers the material to the state's three refineries. These refineries, located in Coffeyville, El Dorado, and McPherson (all in the central-southeast portions of the state), have a combined capacity of 305,900 barrels (12.85 million gallons or 48,600 cubic meters) per day, also roughly 2 percent of the nation's crude-oil refining capacity (DOE 2009b). In 2007, the total petroleum consumption in Kansas was about 83 million barrels (3,500 million gallons or 13.2 million cubic meters), which represented 1.1 percent of the total national consumption (DOE 2009b).

Coal is the primary source of energy for the electrical power plants in Kansas, but almost all of the coal used in the state is imported from other states, primarily Wyoming. There is one small coal mine in Kansas and it is in the east (DOE 2009b). There is no identified production or significant use of coal in the area of Stevens County.

3.6.3 CONSTRUCTION MATERIALS

There are no significant quantities of construction materials manufactured in the region around the Biorefinery Project site. According to records maintained by the U.S. Department of Commerce, Bureau of Economic Analysis, all of Stevens County, Kansas, had a total of 80 manufacturing jobs in 2006 (BEA 2008a). In the surrounding counties (that is, Morton, Stanton, Grant, Haskell, and Seward counties in Kansas, and Texas and Beaver counties in Oklahoma), only Grant County, Kansas, and Beaver County, Oklahoma, have manufacturing jobs. Grant County and Beaver County list 166 and 85 manufacturing jobs, respectively (BEA 2008a). The Bureau of Economic Analysis records do not provide further information on the nature of the manufacturing activities in the counties.

The U.S. Census Bureau also maintains records on the types of industries that occur at various locations across the country, including at the county level (Bureau of the Census 2005). According to information from the 2002 economic census, the number of manufacturing establishments and employees in Stevens County, Kansas, were either 0 or below the publication threshold. The surrounding counties of Morton, Stanton, Grant, and Haskell in Kansas and Beaver in Oklahoma reported the same status. The remaining surrounding counties, Seward in Kansas and Texas in Oklahoma, listed manufacturing activities. Seward County, Kansas, listed 10 establishments with 2,500 to 4,999 employees. Of those 10 establishments, 3 were identified with specific information on the nature of the manufacturing activity and all were in the food manufacturing – animal processing area. Texas County, Oklahoma, listed nine manufacturing establishments with 1,000 to 2,400 employees. Five of those establishments were identified with specific manufacturing information, and, like Seward County, all five were in the food manufacturing – animal process area. Even moving outward from Stevens County and considering the next closest counties of Hamilton, Kearny, Finney, Gray, and Meade in Kansas, Cimarron and Harper in Oklahoma, and even Baca County in Colorado, all yielded similar results. All of these counties, except Finney, listed manufacturing establishments and employees either at 0 or below the publication threshold. Finney County, Kansas, was listed with 32 manufacturing establishments, but of the 6 with specific manufacturing information, all were in the food manufacturing – animal process area.

Based on the above, construction materials for the biorefinery would come from outside the general area of Hugoton and Stevens County.

3.7 Wastes and Hazardous Materials

This section describes the existing conditions associated with wastes and hazardous materials management within the region of influence. This region of influence includes the permitted solid and hazardous waste disposal and recycling facilities that are located at distances from the Biorefinery Project site that would allow economical service to the biorefinery. This section also describes hazardous materials users and suppliers within Stevens County. Section 3.6 discusses existing Hugoton municipal utilities, including sewer services (wastewater) and sanitation services (solid waste).

3.7.1 WASTE MANAGEMENT

3.7.1.1 Solid Waste, Construction Debris, and Demolition Waste

Three active, permitted municipal solid waste landfills (Stevens County, Morton County, and Seward County) are located within the region of influence. One additional *construction and demolition waste* landfill/municipal solid waste transfer station (Grant County) is located in the region. There is a municipal solid waste transfer station in Guymon, Oklahoma, but this facility transfers municipal solid waste to municipal solid waste landfills in Oklahoma and exports waste to Kansas. Therefore, the active, permitted municipal solid waste landfills in the region of influence considered for waste receipt from the biorefinery are all located in Kansas.

A municipal solid waste landfill is a solid-waste disposal area where residential waste is placed for disposal. A municipal solid waste landfill also may receive other nonhazardous wastes, including commercial solid waste, sludge, and industrial solid waste. As defined by Kansas Statutes Annotated (K.S.A.) 65-3424, “Solid and Hazardous Waste,” solid waste in Kansas means garbage, refuse, waste tires and other discarded materials, including, but not limited to solid and semisolid sludges, liquid, and contained gaseous waste materials resulting from industrial, commercial, agricultural, and domestic activities. As defined by subsection (f) of K.S.A. 65-3430, solid waste does not include hazardous wastes, recyclables, or the waste of domestic animals as described by subsection (a)(1) of K.S.A. 65-3409. Industrial waste means all solid waste resulting from manufacturing, commercial, and industrial processes not suitable for discharge to a sanitary sewer or treatment in a community sewage treatment plant or is not beneficially used in a manner that meets the definition of recyclables. Industrial waste includes but is not limited to mining wastes from extraction, beneficiation, and processing of ores and minerals unless those minerals are returned to the mine site; fly ash, bottom ash, slag, and flue gas emission wastes generated primarily from the combustion of coal or other fossil fuels; cement kiln dust; waste oil and sludges; waste oil filters; and fluorescent lamps.

The Stevens County municipal solid waste landfill, described in Section 3.6.1.3, is located northeast of the city of Hugoton, approximately 0.5 mile (0.8 kilometer) south of the junction of US-56 and US-25.

The Morton County municipal solid waste landfill is located approximately 8 miles (13 kilometers) west of Rolla, Kansas, and approximately 25 miles (40 kilometers) southwest of the Biorefinery Project site. The Morton County municipal solid waste landfill cannot accept waste from outside Morton County. Morton County is permitted to operate this municipal solid waste landfill under Permit No. 0197. The total area permitted to receive waste is 52 acres (0.210 square kilometer). The average annual volume of waste and soil cover placed in the landfill is 24,186 cubic yards (18,492 cubic meters). Based on the reported average compacted density of waste received at this landfill of 650 pounds per cubic yard, the weight would be 7,860 tons (7,130 metric tons) per year. The original total volume capacity of the landfill site was 2,129,608 cubic yards (1,628,213 cubic meters). As of the date of the 2008 permit renewal form, the total remaining volume capacity of the landfill was 2,080,078 cubic yards (1,590,344 cubic meters). Based on the current average annual waste placement rate, the estimated remaining life of the landfill is 86 years (KDHE 2008d).

The Seward County municipal solid waste landfill is located northeast of Liberal, Kansas, and approximately 33 miles (53 kilometers) southeast of the Biorefinery Project site. The Seward County municipal solid waste landfill receives municipal solid waste from Liberal, Kansas, and the Seward County area including counties outside of Seward. Seward County is permitted to operate this municipal solid waste landfill under Permit No. 0140. The total area permitted to receive waste is 198 acres (0.801 square kilometer). The annual average tonnage received is 75,000 tons (68,040 metric tons). The average annual volume of waste and soil cover placed in the landfill is 147,500 cubic yards (112,800 cubic meters). The original total volume capacity of the landfill site was 8,687,500 cubic yards (6,642,120 cubic meters). As of the date of the 2008 permit renewal form, the total remaining volume capacity of the landfill was 6,214,500 cubic yards (4,751,360 cubic meters). Based on the current average annual waste placement rate, the estimated remaining life of the landfill is 42 years (KDHE 2008e).

The Grant County *construction and demolition waste landfill* is located approximately 3 miles (4.8 kilometers) east of Ulysses, Kansas, and approximately 30 miles (48 kilometers) north of the Biorefinery Project site. This facility acquired an amendment to Permit No. 0668 in 1997 to operate a construction and demolition landfill. The total permitted area to receive waste is 12 acres (0.049 square kilometer) and the area currently open is 2 acres (0.008 square kilometer). The permit was most recently renewed by the Kansas Department of Health and Environment in 2008 (KDHE 2008f). The 2008 Landfill Permit renewal form did not indicate the permitted remaining capacity or lifetime of this facility. The Grant County construction and demolition waste landfill manager indicated there are no permit conditions limiting the amount of waste received per day or year at the facility (Graber 2008).

A construction and demolition waste landfill is a solid-waste disposal area used exclusively for the disposal on land of construction and demolition wastes. Under K.A.R. 65-34, construction and demolition waste means solid waste resulting from the construction, remodeling, repair, and demolition of structures, roads, sidewalks, and utilities; untreated wood and untreated sawdust from any source; treated wood from construction or demolition projects; small amounts of municipal solid waste generated by the consumption of food and drinks at construction or demolition sites, including but not limited to cups, bags, and bottles; furniture and appliances from which ozone-depleting chlorofluorocarbons have been removed in accordance with the provisions of the *Clean Air Act*; solid waste consisting of motor vehicle window glass; and solid waste consisting of vegetation from land clearing and grubbing, utility maintenance, and seasonal or storm-related cleanup. Such wastes include, but are not limited to bricks, concrete, and other masonry materials, roofing materials, soil, rock, wood, wood products, wall or floor coverings, plaster, drywall, plumbing fixtures, electrical wiring, electrical components containing no hazardous materials, non-asbestos insulation, and construction related packaging. Construction and demolition waste do not include waste material containing friable asbestos, garbage, furniture, and appliances from which ozone-depleting chlorofluorocarbons have not been removed in accordance with the provisions of the *Clean Air Act,* electrical equipment containing hazardous materials, tires, drums, and containers even though such wastes resulted from construction and demolition activities. Clean rubble that is mixed with other construction and demolition waste during demolition or transportation shall be considered to be construction and demolition waste.

3.7.1.2 Hazardous Waste

The closest permitted hazardous waste facilities are in Dodge City and Wichita, Kansas (KDHE 2006).

Safety-Kleen Systems, Inc. has 10-day transfer facilities in Dodge City, Kansas and Wichita, Kansas. These facilities are permitted to transport, package, and temporarily (10-day maximum) store hazardous wastes prior to transporting the wastes to treatment/disposal facilities. The wastes would be tested, packaged, labeled, and manifested prior to transport to the Safety-Kleen treatment/disposal facility in Denton, Texas (EPA ID Number TXD077603371).

Clean Harbors of Kansas, LLC has 10-day transfer facilities in Wichita, Kansas and Lenexa, Kansas. These facilities are permitted to transport, package, and temporarily (10-day maximum) store hazardous wastes prior to transporting the wastes to treatment/disposal facilities. The wastes would be tested, packaged, labeled, and manifested prior to transport to the Clean Harbors treatment/disposal facility in El Dorado, Arkansas (EPA ID Number ARD069748192).

Univar, USA, Inc. has a 10-day transfer facility in Wichita, Kansas. Similar to the 10-day transfer facilities discussed above, this facility is permitted to transport, package, and temporarily store hazardous wastes prior to transporting the wastes to treatment/disposal facilities. Univar does not own treatment/disposal facilities. The wastes would be transported to permitted transport/storage/disposal facilities in Univar's approved network based on the types of wastes, transportation costs, and disposal fees (Stewart 2008).

3.7.2 HAZARDOUS MATERIALS MANAGEMENT

For the purposes of this EIS, hazardous materials (also known as dangerous goods) are considered any solid, liquid, or gas that can harm people, other living organisms, property, or the environment. Chemicals are substances with a specific chemical composition. Some chemicals would be classified as hazardous materials and others not.

Stevens County Emergency Services receives annual chemical inventory reports from chemical users in Stevens County (Schechter 2008). Facilities covered by the *Emergency Planning and Community Right-to-Know Act* requirements must submit an annual Emergency and Hazardous Chemical Inventory Form to the Local Emergency Response Commission, the State Emergency Response Commission, and the local fire department. Based on these chemical inventory reports, Stevens County Emergency Services indicated the primary chemical use in the county is related to oil- and gasfield development (salt water and crude oil), agricultural lands and cooperatives (anhydrous ammonia, fertilizers, agriculture-related chemicals), and water treatment (chlorine). Stevens County Emergency Services identified no concentrated inventories of large amounts of chemicals in the County (Schechter 2008).

The Biorefinery Project site is adjoined by grain elevators, an asphalt plant, an industrial park, and agricultural land. The industrial park includes tenants that cater to the oilfield, agribusiness, and construction industries. Some of these tenants store and sell oilfield supplies, agricultural fertilizers and chemicals, asphalt manufacturing chemicals and materials, and construction materials and supplies. A golf course and an airport are also located in the immediate vicinity of the Project site. The golf course uses chemicals and fertilizers for course maintenance. The airport stores and sells aviation fuels. Fertilizers and agricultural chemicals are used on croplands in the vicinity of the Project site.

The Biorefinery Project site is used for cattle grazing and crop production. The land consists of eight fields, ranging from 9 to 200 acres in area. The types of herbicides currently applied on various fields of the land include Roundup®, Bicep Lite II Mag®, 2,4-D, and 2,4-D amine. Pesticides currently applied on various fields of the land include Capture®. Fertilizers applied to the fields include anhydrous ammonia, granular phosphorus, and a urea-ammonium-nitrate solution. Fungicide applications include Headline®. These agricultural chemicals are purchased locally (Roach 2008b).

3.8 Transportation

This section summarizes the road and rail *transportation infrastructure* in the vicinity of the Biorefinery Project site. The region of influence for transportation infrastructure varies according to the activity: (1) biomass collection – the region of influence is the distance from the Project site to potential biomass collection locations (50 miles [80 kilometers]); (2) offsite biomass storage – the region of influence is the distance from the Project site to potential offsite biomass storage locations (30 miles [48 kilometers]); and (3) worker commute – the region of influence is the distance that workers would potentially commute to the Project site (50 miles).

3.8.1 ROAD INFRASTRUCTURE

Kansas has the fourth largest number of public roads in the nation. The State Highway System comprises approximately 9,500 miles (15,000 kilometers), or 7 percent, of the more than 135,000 miles (217,000 kilometers) of public roads in Kansas, and carries about 34 percent of the state's total travel. County and township roads comprise about 110,000 miles (180,000 kilometers), or 82 percent of the public roads in Kansas, and carry 15 percent of the state’s total travel. Municipal roads comprise about 14,000 miles (23,000 kilometers), or 10 percent of the public roads in Kansas, and carry 26 percent of the state’s total travel (KDOT 2005a).

From 2003 to 2007, there was an average of about 71,000 motor vehicle accidents in Kansas. The motor vehicle accident rate was about 2.4 per million vehicle miles (1.5 per million vehicle kilometers). Over this same period, there was an average of about 23,000 injuries and 450 fatalities from motor vehicle accidents in Kansas. The motor vehicle injury rate was about 0.78 per million vehicle miles (0.48 per million vehicle kilometers) and the motor vehicle fatality rate was about 1.5 per 100 million vehicle miles (0.93 per 100 million vehicle kilometers). From 2003 to 2007, there was an average of about 3,900 accidents per year, 1,200 injuries per year, and 78 fatalities per year from accidents involving large trucks in Kansas (KDOT 2004, 2005b, 2006, 2007, 2008). Table 3-13 lists the accident, injury, and fatality rates for large trucks in Kansas for interstates, primary roads, and other roads. Total accident, injury, and fatality rates are also listed. These data were taken from an Argonne National Laboratory report (Saricks and Tompkins 1999) and were adjusted to account for under-reporting in the Motor Carrier Management Information System using the data contained in the evaluation of the Information System (Blower and Matteson 2003), which resulted in the accident, injury, and fatality rates in the Argonne report being increased by factors of 1.64, 1.20, and 1.57, respectively.

Table 3-13. Large truck accident rates for Kansas.

Parameter	Interstate	Primary	Other	Total (all roads)
Accident rate (per 10 million truck-mile)	7.50	13.7	8.29	10.1
Injury rate (per 10 million truck-mile)	4.91	9.29	4.89	6.66
Fatality rate (per 100 million truck-mile)	1.32	11.9	2.56	5.80

Source: Saricks and Tompkins 1999; adjusted using data from *Evaluation of the Motor Carrier Management Information System Crash File, Phase One* (Blower and Matteson 2003) to account for under-reporting.
Note: To convert "per miles" to "per kilometers," multiply by 0.63127.

About 124,000 miles (200,000 kilometers) of roads in Kansas are classified as rural and about 11,000 miles (18,000 kilometers) are classified as urban. The Biorefinery Project site is located adjacent to and west of the city of Hugoton in Stevens County, Kansas, and is surrounded by Stanton, Grant, Haskell, Morton, and Seward counties in Kansas, and Cimarron, Texas, and Beaver counties in Oklahoma. There are about 1,100 miles (1,800 kilometers) of public roads within Stevens County, all of which are classified as rural. About 220,000 vehicle miles (350,000 vehicle kilometers) are traveled daily on these roads (KDOT 2005a). Table 3-14 lists the miles of public road and vehicle miles traveled daily for the other counties surrounding the Project site. Table 3-15 lists the distances from Hugoton to the county

Table 3-14. Miles of road and daily vehicle miles traveled for the counties surrounding the Biorefinery Project site.

		Rural Areas		Urban areas	
County	State	Miles of road	Daily vehicle miles traveled	Miles of road	Daily vehicle miles traveled
Stevens[a]	Kansas	1,100	220,000	--	--
Stanton[a]	Kansas	730	120,000	--	--
Grant[a]	Kansas	770	180,000	38	38,000
Haskell[a]	Kansas	830	250,000	--	--
Morton[a]	Kansas	690	110,000	--	--
Seward[a]	Kansas	770	310,000	140	230,000
Beaver[b]	Oklahoma	2,352	426,000	--	--
Cimarron[b]	Oklahoma	1,763	245,000	--	--
Texas[b]	Oklahoma	2,773	644,000	111	155,000

Note: To convert miles to kilometers and miles traveled to kilometers traveled, multiply by 1.6093.
a. Source: KDOT 2005a.
b. Source: Maxwell 2008.

seats of Stanton, Grant, Haskell, Morton, Seward, Cimarron, Texas, and Beaver counties. Table 3-15 also lists the distances from Hugoton to Dodge City and Garden City, Kansas, the closest cities with populations greater than 25,000, the distance from Hugoton to Wichita, Kansas, which has a population of over 350,000, and the distance from Hugoton to Kansas City, Kansas.

From 2003 to 2007, there was an average of about 99 motor vehicle accidents per year in Stevens County. Over this same period, there was an average of about 37 injuries and three fatalities per year from motor vehicle accidents (KDOT 2004, 2005b, 2006, 2007, 2008). Table 3-16 lists the number of motor vehicle accidents, injuries, and fatalities in the other counties surrounding the Biorefinery Project site.

Table 3-15. Distances to Hugoton, Kansas.

City	State	County	Distance to Hugoton, Kansas (miles)
Liberal	Kansas	Seward	33
Sublette	Kansas	Haskell	37
Ulysses	Kansas	Grant	30
Johnson City	Kansas	Stanton	50
Elkhart	Kansas	Morton	33
Boise City	Oklahoma	Cimarron	73
Guymon	Oklahoma	Texas	41
Beaver	Oklahoma	Beaver	70
Dodge City	Kansas	Ford	106
Garden City	Kansas	Finney	70
Wichita	Kansas	Sedgwick	235
Kansas City	Kansas	Wyandotte	436

Notes: Distances obtained using Mapquest®. To convert miles to kilometers, multiply by 1.6093.

Table 3-16. Motor vehicle accidents, injuries, and fatalities for the counties surrounding the Biorefinery Project site.

County	State	Accidents (per year)	Injuries (per year)	Fatalities (per year)
Stevens[a]	Kansas	99	37	3.0
Stanton[a]	Kansas	37	22	0.80
Grant[a]	Kansas	130	46	1.6
Haskell[a]	Kansas	89	42	3.2
Morton[a]	Kansas	59	23	0.80
Seward[a]	Kansas	430	110	5.2
Cimarron[b]	Oklahoma	65	36	2.8
Texas[b]	Oklahoma	330	130	4.8
Beaver[b]	Oklahoma	110	60	5.0

a. Source: KDOT 2004, 2005b, 2006, 2007, 2008. Accidents, injuries, and fatalities are the average for the period 2003 to 2007.

b. Source: OHSO 2004, 2005a, 2005b, 2006, 2007. Accidents, injuries, and fatalities are the average for the period 2002 to 2006.

Figure 1-1 in Chapter 1 of this EIS illustrates the location of the Biorefinery Project site. The Project site is bordered by US-56 and K-51 to the south, Road 10 to the west, Road P to the north, and Road 12 to the east. The most direct route to the Project site from US-56 would be via Road 11. According to annual average daily traffic counts performed from July 2006 to June 2007 by the Kansas Department of Transportation, the total volume of vehicles close to the Project site was 2,480; the total volume of heavy commercial vehicles was 510.

A traffic impact analysis prepared for Abengoa Bioenergy (TranSystems 2008) describes the traffic conditions near the Biorefinery Project site using *level of service*. Level of service is a qualitative measure describing operational conditions within a traffic stream based on service measures such as speed and travel time, freedom to maneuver, traffic interruptions, comfort, and convenience (TRB 2000). Level of service is rated from A to F: Service level A represents the most desirable condition with free-flow movement of traffic and minimal delays. Service level F generally indicates severely congested conditions with excessive delays to motorists. Intermediate grades of B, C, D, and E reflect incremental increases in the average delay per stopped vehicle. Delay is measured in seconds per vehicle. Table 3-17 shows the upper limit of delay associated with each level of service for signalized and unsignalized intersections (TranSystems 2008).

Table 3-17. Intersection level of service delay thresholds.

Level of service	Signalized intersection	Unsignalized intersection
A	less than 10 seconds	less than 10 seconds
B	less than 20 seconds	less than 15 seconds
C	less than 35 seconds	less than 25 seconds
D	less than 55 seconds	less than 35 seconds
E	less than 80 seconds	less than 50 seconds
F	greater than or equal to 80 seconds	greater than or equal to 50 seconds

Source: TranSystems 2008.

In addition to level of service, the traffic impact analysis evaluated the volume-to-capacity ratio for traffic lanes at intersections and the capacity utilization of the intersection. The volume-to-capacity ratio reflects, regardless of delay, the ability to accommodate the existing or projected traffic volumes over the course of a peak hour. A volume-to-capacity ratio of 1.00 means that a traffic lane is operating at 100 percent of its capacity. The overall performance of an intersection was quantified using the capacity utilization. A capacity utilization of 1.00 means that an intersection is operating at 100 percent of its capacity.

The level of service rating deemed acceptable varies by community, type of road or intersection, and traffic control device. In communities similar to Hugoton, Kansas, service level C for signalized intersections is often found to be acceptable. However, at unsignalized intersections, service levels D, E, and F are often accepted for low to moderate traffic volumes where the installation of a traffic signal is not warranted by the conditions at the intersection, or the location has been deemed undesirable for signalization for other reasons (TranSystems 2008).

The traffic impact analysis evaluated existing traffic conditions at nine intersections near the Biorefinery Project site for the peak hours during mornings and afternoons. Table 3-18 summarizes the levels of service, delay times, and volume-to-capacity ratios for each intersection. Table 3-19 summarizes the overall capacity utilization of each intersection. All intersections performed at service level A or B, which indicates minimal delays. The maximum volume-to-capacity ratio for the lanes at the nine intersections was 0.19 for the southbound lane of the intersection of US-56 and K-25/Road 13, which indicates this lane is operating at 19 percent of its capacity. Overall, the capacity utilization of this intersection was about 30 percent. The maximum capacity utilization for the nine intersections was for the intersection of US-56/K-25/Main Street and K-51, which was observed as utilizing about 36 percent of its capacity.

Table 3-18. Existing levels of service, delay times, and volume-to-capacity ratios at intersections near the Biorefinery Project site.

Intersection	Morning peak hour			Afternoon peak hour		
	Level of service	Delay (seconds)	Volume to capacity	Level of service	Delay (seconds)	Volume to capacity
US-56/K-25/K-51 and Road 10						
Eastbound left	A	0.0	0.00	A	0.2	0.00
Westbound left	A	0.2	0.00	A	0.4	0.00
Northbound	A	8.7	0.00	A	0.0	0.00
Southbound	A	9.8	0.01	A	8.5	0.00
US-56/K-25/K-51 and Road 11						
Eastbound left	A	1.4	0.01	A	1.4	0.01
Westbound left	A	0.2	0.00	A	0.2	0.00
Northbound	A	8.5	0.00	B	10.4	0.00
Southbound	A	9.3	0.03	A	9.6	0.05
US-56/K-25/K-51 and Road 12						
Eastbound left	A	1.6	0.01	A	0.7	0.01
Westbound left	A	2.9	0.02	A	2.8	0.02
Northbound	A	9.1	0.03	A	9.8	0.05
Southbound	B	10.2	0.07	B	10.7	0.06
US-56/K-25/Main Street and K-51						
Eastbound	A	8.8	--	A	9.6	--
Westbound	A	8.8	--	A	8.9	--
Northbound	A	8.2	--	A	8.5	--
Southbound	A	8.8	--	A	9.2	--
US-56/K-25/Main Street and First Street/Road P						
Eastbound	B	10.1	0.07	B	10.1	0.07
Westbound	A	9.9	0.05	B	10.5	0.07
Northbound left	A	1.2	0.00	A	0.7	0.01
Southbound left	A	1.0	0.00	A	0.2	0.00
US-56 and K-25/Road 13						
Northbound	B	10.6	0.08	B	10.4	0.08
Southbound	B	11.1	0.19	B	10.9	0.19
Northeast-bound left	A	3.1	0.04	A	2.4	0.03
Southwest-bound left	A	2.2	0.01	A	2.1	0.01
Road P and Road 10						
Eastbound	A	0.4	0.00	A	0.0	0.00
Westbound	A	0.0	0.00	A	0.0	0.00
Northbound	A	9.0	0.00	A	8.6	0.00
Southbound	A	8.7	0.00	A	8.8	0.00
Road P and Road 11						
Eastbound	A	0.0	0.00	A	0.0	0.00
Westbound	A	2.0	0.00	A	1.8	0.00
Northbound	A	8.6	0.01	A	8.6	0.02
Southbound	A	0.0	0.00	A	0.0	0.00
Road P and Road 12						
Eastbound	A	0.4	0.00	A	0.2	0.00
Westbound	A	0.0	0.01	A	0.9	0.00
Northbound	A	9.2	0.01	A	8.9	0.01
Southbound	A	8.8	0.02	A	8.9	0.03

Source: TranSystems 2008.

Table 3-19. Capacity utilization of intersections near the Biorefinery Project site.

Intersection	Morning peak hour capacity utilization (percent)	Afternoon peak hour capacity utilization (percent)
US-56/K-25/K-51 and Road 10	13.3	13.4
US-56/K-25/K-51 and Road 11	21.4	22.5
US-56/K-25/K-51 and Road 12	22.1	24.9
US-56/K-25/Main Street and K-51	34.7	35.7
US-56/K-25/Main Street and First Street/Road P	17.0	18.0
US-56 and K-25/Road 13	29.9	28.9
Road P and Road 10	13.3	13.3
Road P and Road 11	15.1	15.2
Road P and Road 12	20.0	20.0

Source: TranSystems 2008.

3.8.2 RAIL INFRASTRUCTURE

The Cimarron Valley Railroad operates 254 miles (409 kilometers) of track in southwestern Kansas, southeastern Colorado, and in the western panhandle of Oklahoma. The Cimarron Valley Railroad runs southwest out of Dodge City to Satanta, Kansas. At Satanta, the line splits and the southern route goes to Boise City, Oklahoma. The western route continues to Springfield, Colorado. The Cimarron Valley Railroad owns 182 miles (293 kilometers) of track in Kansas (KDOT n.d.).

The primary commodities this railroad ships include grain and grain-related products. Secondary commodities are fertilizer, carbon black, other chemicals, and various miscellaneous shipments. Major shippers on the rail line in Kansas include Johnson Coop, Johnson; Sublette Coop, Sublette; Elkhart Coop, Elkhart; Columbian Chemical, Hickok; Dodge City Coop, Ensign and Montezuma; and Seaboard Farms, Hugoton. The Cimarron Valley Railroad handled approximately 10,105 carloads in 2005 (KDOT n.d.).

As shown in Figure 3-18, the Cimarron Valley Railroad runs generally east to west through the central part of the 425-acre (1.7-square-kilometer) buffer area and along the southern property line of the 385-acre (1.6-square-kilometer) area of the Biorefinery Project site.

From 2003 to 2007, there was an average of about 35,000 train-miles (56,000 train-kilometers) per year of traffic on the Cimarron Valley Railroad. Over this same period, there was an average of about three accidents or incidents per year on the Cimarron Valley Railroad and the accident/incident rate was about 77 accidents or incidents per million train-miles (48 per million train-kilometers). From 2003 to 2007, there were no fatalities and five injuries associated with railroad accidents or incidents on the Cimarron Valley Railroad (FRA 2008).

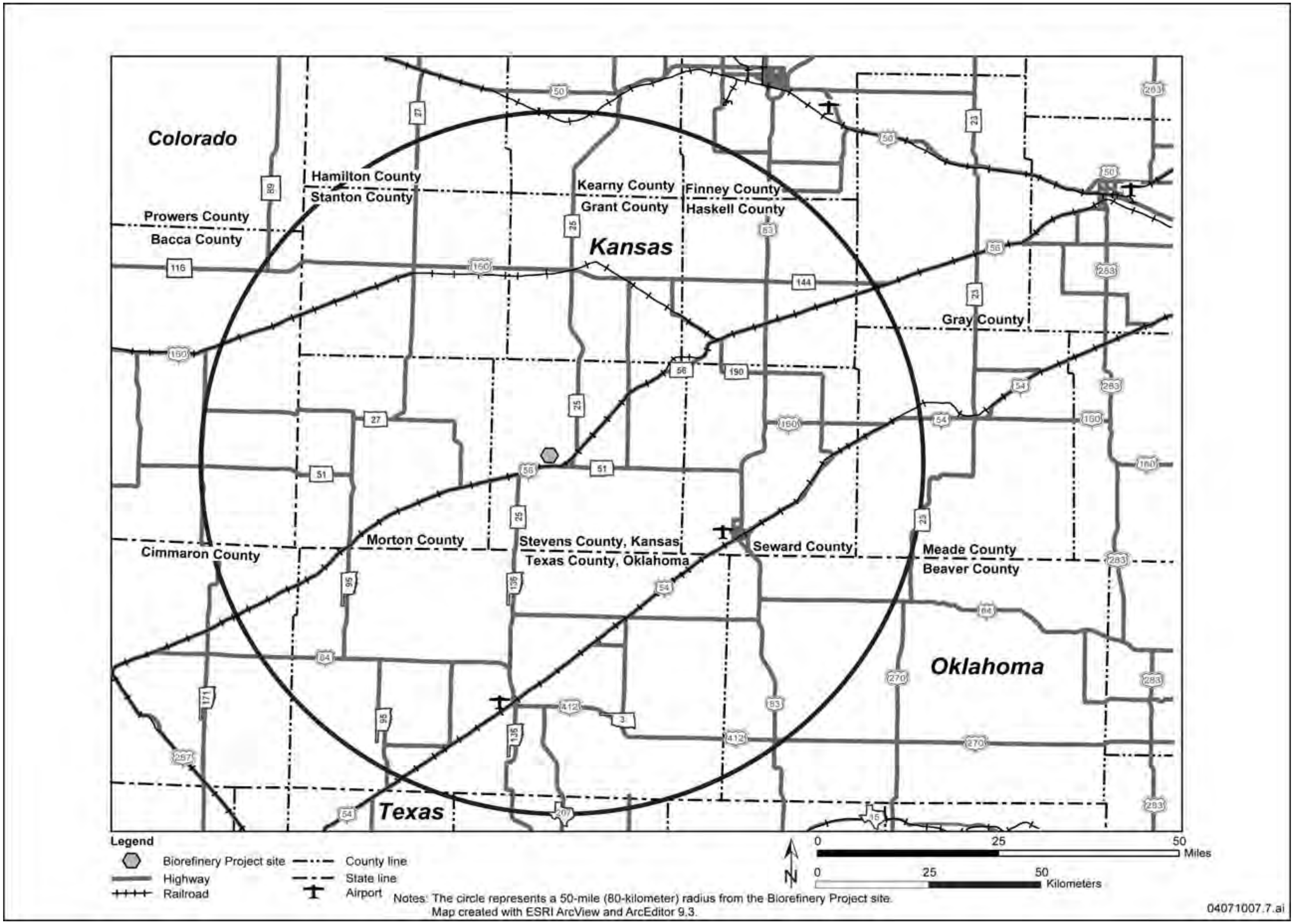

Figure 3-18. Map of rail infrastructure near the Biorefinery Project site.

3.9 Aesthetics

This section describes the aesthetic conditions of the Biorefinery Project site and associated regions of influence in terms of visual resources, noise, and odor. Section 3.9.1 describes the visual landscape and impairments, Section 3.9.2 describes noise measurement and background noise, and Section 3.9.3 discusses influences and existing sources of odor.

3.9.1 VISUAL RESOURCES

The region of influence for visual impacts resulting from the Proposed Action is a 1-mile (1.6-kilometer) radius around the Biorefinery Project site (Chapter 1, Figure 1-2). The city of Hugoton lies within the region of influence and is approximately 1 mile east of the 385-acre (1.6-square kilometer) biorefinery parcel and adjacent to the 425-acre (1.7-square kilometer) buffer area. Structural features resulting from the Proposed Action and Action Alternative would be visible from Hugoton.

The Biorefinery Project site comprises agricultural land, and agricultural properties surround the majority of the Project site to the west and north. The Project site and surrounding properties are relatively flat with sparse trees along US-56/K-51. Cargill, Inc., Seaboard Farms, and the West Industrial Park are located adjacent to the south of the Project site. Grain storage silos are located at both Cargill, Inc. and Seaboard Farms. Some tenants of the West Industrial Park include the Stevens County Asphalt Plant, Sunrise Oilfield Supply, Grower Solutions, Cropland Co-op, and AB&J, LLC. Most of the structures at the West Industrial Park are one- or two-story, rectangular metal buildings. The Stevens County Asphalt Plant contains storage tanks that are approximately three stories tall. Beyond the industrial park to the south are additional agricultural properties. Forewinds Golf Course is less than 0.25 mile (0.4 kilometer) to the west of the Project site, west of Road 10. The Hugoton Municipal Airport is south of US-56/K-51, immediately south of the buffer area.

Current visual impairments include structural features, such as buildings, and perceptible emissions, such as stack emissions or *fugitive dust*. Existing permitted sources of potential visible emissions include Seaboard Farms and the Stevens County Asphalt Plant. Specific activities that could produce dust and affect visibility include grain loading and unloading at Seaboard Farms and aggregate handling at Stevens County Asphalt Plant.

Another source of visual impairment in the region of influence is night lighting at the Hugoton Municipal Airport. Some of the buildings in the West Industrial Park have small security lights that are turned on at night, but there are no major night operations that require intense amounts of night lighting.

3.9.2 NOISE

The region of influence for noise impacts was determined by evaluating the nearest residents and sensitive noise receptors such as schools, libraries, places of worship, and medical centers. The region of influence is approximately 1-mile (1.6 kilometers) around the Biorefinery Project site and includes the entire city of Hugoton (Chapter 1, Figure 1-2). This section discusses the affected environment in terms of noise measurement and background noise sources and levels.

3.9.2.1 Noise Measurement

Noise is unwanted sound that interferes with normal activities or otherwise diminishes the quality of the environment. Noise may be intermittent or continuous, steady or impulsive, *stationary* or *transient*. Stationary sources are normally related to specific land uses, for example, housing tracts or industrial facilities. Transient noise sources move through the environment, either along established paths or randomly, for example, trains.

The human hearing system does not respond equally to all frequencies of sound. For sounds normally heard in the environment, low frequencies (below 250 Hertz) and very high frequencies (above 10,000 Hertz) are less audible than the frequencies in between. Therefore, it is appropriate to apply a weighting function to the noise spectrum, which approximates the response of the human ear. This is called *A-weighting* the frequency content of a noise signal and has been found to have an excellent correlation with the human subjective judgment of noise annoyance (Hanson et al. 2006). The sound pressure levels measured using the A-weighting network are expressed as A-weighted decibels (dBA). Table 3-20 identifies typical A-weighted sound levels for various sources.

Table 3-20. Typical decibel levels of noise encountered in daily life and industry.

Noise	Level (dBA)
Rustling leaves	20
Room in a quiet dwelling at midnight	32
Window air conditioner	55
Conversational speech	60
Busy restaurant	65
Loudly reproduced orchestral music in large room	82
Beginning of hearing damage (if prolonged exposure)	85
Heavy city traffic	92
Home lawn mower	98
Jet airliner [500 feet (150 meters) overhead]	115
F-15 aircraft (500 feet overhead, afterburner power)	123

Source: Newman and Beattie 1985, format modified.
Note: When distances are not specified, sound levels are the values at the typical location of the machine operators.
dBA = A-weighted decibel.

A characteristic of environmental noise is that it is not steady, but varies in amplitude from one moment to the next. To account for these variations in the sound pressure level with time, and to assess environmental noise in a consistent and practical manner, analysts use a statistical approach to reduce the time-varying levels to single numbers. Two commonly used single-number evaluators are the *equivalent sound level* and the *day-night average sound level* (Hanson et al. 2006). The equivalent sound level describes an individual's cumulative exposure from all sources of noise over a specified period of time. The day-night average sound level describes an individual's cumulative exposure from all sources of noise over a full 24 hours, with any noise exposure occurring between 10 p.m. and 7 a.m. increased by 10 dBA to account for an individual's greater nighttime sensitivity to noise.

Noise can interrupt ongoing activities and can result in community annoyance, especially in residential areas. In general, most residents become highly annoyed when noise interferes significantly with activities such as sleeping, talking, noise-sensitive work, and listening to radio, television, or music

(Hanson et al. 2006). Sound levels that cause annoyance in people vary greatly by individual and background conditions. The EPA recommends indoor and outdoor sound levels of no more than 45 dBA and 55 dBA, respectively, for avoidance of annoyance (EPA 1978).

A one-time exposure to an intense "impulse" sound, such as an explosion, or by continuous exposure to loud sounds over an extended period of time can cause hearing loss. Long or repeated exposure to sounds at or above 85 dBA can cause hearing loss. The louder the sound, the shorter the time before hearing loss can occur. Sounds less than 75 dBA, even after long exposure, are unlikely to cause hearing loss (NIDCD 2007). The National Institute of Occupational Safety and Health recommends 85 dBA as an 8-hour time-weighted average exposure level. Exposures at or above this level are considered hazardous (NIOSH 1998). The Occupational Safety and Health Administration requires a hearing conservation program be in place whenever an employee's noise exposure equals or exceeds this level [29 CFR 1910.95(c)(1)].

3.9.2.2 Background Noise Sources and Levels

The Biorefinery Project site, which comprises approximately 810 acres (3.3 square kilometers) of row-cropped agricultural land, is within an area bordered on the south by US-56/K-51, County Road 10 to the west, Rural Road P to the north, and Rural Road 12, which is east of the site along the western edge of Hugoton. The biorefinery facilities would be developed on the western 385 acres (1.6 square kilometers) of the site, and the remaining 425 acres (1.7 square kilometers) would act as a buffer between the biorefinery production facilities and the city of Hugoton.

No data exist for *ambient noise* in the area. The typical day-night average sound level for agricultural cropland is 44 dBA (EPA 1978). Other sources of noise in the area include traffic noise on US-56 and rail traffic on the Cimarron Valley Railroad, which runs generally east to west through the central part of the buffer area and along the southern property line of the biorefinery parcel; grain elevators, an asphalt plant, an industrial park, an airport to the south; and the city of Hugoton (population approximately 3,700) to the east. Based on the population density of the city of Hugoton, the day-night average sound level for ambient noise in Hugoton can be estimated at 50 dBA (Hanson et al. 2006). The day-night average sound level 50 feet (15 meters) from a highway with traffic at 60 miles (97 kilometers) per hour is typically 70 to 75 dBA (Hanson et al. 2006).

The only noise regulation applicable to the Biorefinery Project site is the Occupational Safety and Health Administration Standard, 29 CFR 1910.95, which applies to occupational noise (Roach 2008c). There are no applicable noise regulations or ordinances for the City of Hugoton, Stevens County, or the State of Kansas.

3.9.3 ODOR

The region of influence for odor is the distance from the source where odors are detectable. Defining the region of influence for odor is dependent on various factors including the ability of a person to detect a smell and his or her tolerance, the presence of multiple chemicals, and the dispersion of odorous compounds due to topography, meteorology, climate, and molecule weight. Local wind patterns also play a role in the ability to detect odors. The region of influence for odor contains populated locations within approximately 1 mile (1.6 kilometers) around the Biorefinery Project site, including the city of Hugoton, West Industrial Park, and Forewinds Golf Course. Odor threshold values define the theoretical minimum concentration of an odorous compound necessary for detection in a certain percentage of the population, typically the mean percentage (AIHA 1989). These threshold values can be compared with ambient concentrations of odorous compounds to determine if odors will be detectable.

Existing sources of odor in the region of influence include agricultural activities, Seaboard Farms (an animal feed mill), and the Stevens County Asphalt Plant. The frequency of the odors coming from the asphalt plant is dependent upon the schedule of plant operations, as odors are only emitted during operations. Earthy, grain storage odors from Seaboard Farms are routine, as grain is held in storage on a regular basis. Agricultural odors are also routine in the area since hog and cattle lots exist as permanent operations. Because Kansas does not have odor regulations, there is no database for odor complaints (Butler 2008). Therefore, it is not known whether the existing odors in the region of influence have been determined to be nuisances by the general public.

3.10 Socioeconomics

This section describes current socioeconomic conditions within a region of influence where most of the project workforce would be expected to reside and, hence, where most impacts to socioeconomic variables would likely be experienced. It also discusses worker flow volumes between neighboring counties of the Biorefinery Project site and Stevens County (the host county). Throughout the socioeconomics section, data are presented for the most current year available. Depending on the source, the most current year may vary.

In its decennial census, the U.S. Census Bureau collects data regarding the flow of workers from their places of residence to their places of work (that is, worker flows) and reports these data at the county level. Table 3-21 contains the residential distribution of Stevens County workers, as provided by the Census Bureau. As the table indicates, Morton, Seward, and Stevens counties, Kansas, and Texas County, Oklahoma, each provide Stevens County with at least 2 percent of the County's workforce. In effect, people finding employment in Stevens County are most likely to reside in one of the four counties. Collectively, these four counties represent the county residence of approximately 93 percent of the workers in Stevens County. Therefore, the region of influence for the Abengoa Biorefinery Project socioeconomic analysis is the four-county area in southwestern Kansas and the Oklahoma panhandle composed of Morton, Seward, and Stevens counties, Kansas, and Texas County, Oklahoma (Figure 3-19).

Table 3-21. Residence-county to workplace-county worker flows, 2000.

Residence	Workplace	Number of Workers	Percent of total workforce in Stevens County
Finley County KS	Stevens County KS	23	1.0
Haskell County KS	Stevens County KS	32	1.4
Morton County KS	Stevens County KS	73	3.1
Seward County KS	Stevens County KS	62	2.6
Stevens County KS	Stevens County KS	1,946	83
Texas County OK	Stevens County KS	67	2.8
Other KS counties	Stevens County KS	158	6.7
Other OK counties	Stevens County KS	15	0.64
Other states	Stevens County KS	43	1.8
Total		2,352	100

Source: USCB 2000a.
Notes: Each of the counties included in this "Other KS Counties," "Other OK Counties," and "Other States" category are home to less than 1 percent of the workers in Stevens County. Total may differ from sums due to rounding.

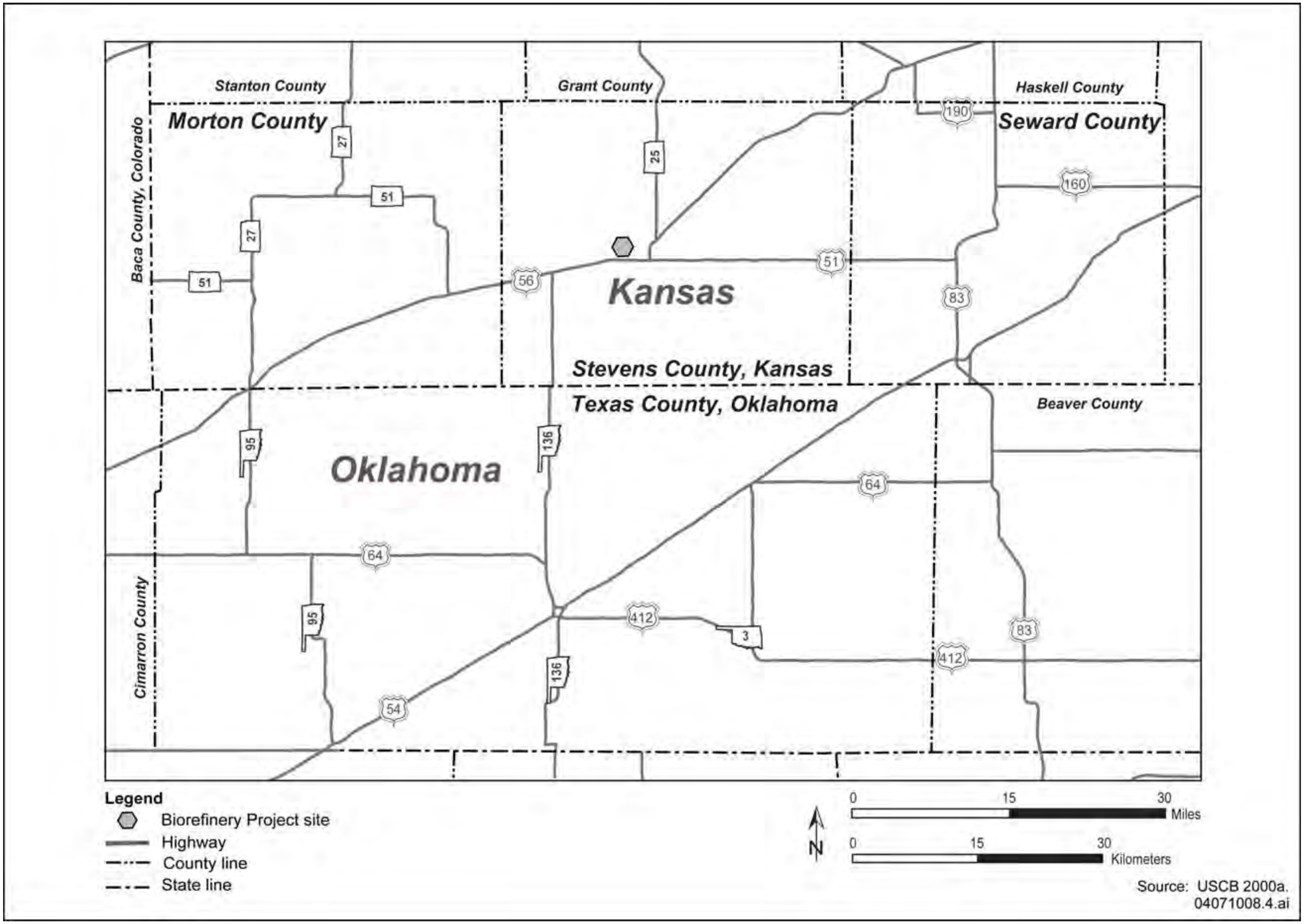

Figure 3-19. Location of socioeconomic region of influence for the Abengoa Biorefinery Project.

3.10.1 POPULATION DATA

From 1990 to 2000, the population in the region of influence, as a whole, grew at a much faster rate than that for the states of Kansas or Oklahoma. The region of influence population increased by approximately 17 percent between 1990 and 2000, while Kansas' population grew by 8.5 percent and Oklahoma's grew by 9.8 percent. Most of the region of influence's growth can be attributed to the growth in Seward County, Kansas, and Texas County, Oklahoma, both of which grew at rates exceeding 20 percent in that decade. Only Morton County experienced a decline in population (USCB 2000b). Within the region of influence, the three Kansas counties are expected to have small declines in baseline population from 2010 to 2025 (KDB 2008). However, the expected population increase of almost 37 percent in the one Oklahoma county in the region of influence, Texas County, will contribute to the region's continued, overall population growth through 2025 (Wallace and Bettis 2002). By 2020, population growth in the region of influence is projected to slow to about 10 percent per decade. Likewise, the growth rate in the states of Kansas and Oklahoma is projected to slow to 4.2 and 6.9 percent, respectively, per decade, by 2020. Table 3-22 presents historic and projected populations in the region of influence, Kansas, and Oklahoma. The U.S. Census Bureau estimates the 2007 population of the counties as follows: Morton County 3,038; Seward County 23,109; Stevens County 5,061; and Texas County 20,032 (USCB 2008a), for a total of 51,240 residents in the region of influence.

Table 3-22. Historic and projected populations for the region of influence, Kansas, and Oklahoma.

	1990[c]	2000	Percent change 1990 to 2000	2005	2010
Kansas[a]	2,481,359	2,691,756	8.5%	2,756,353	2,818,880
Morton County[a]	6,203	6,109	-1.5%	6,174	6,228
Seward County[a]	18,726	22,567	21%	22,603	22,551
Stevens County[a]	5,059	5,475	8.2%	5,252	5,206
Oklahoma[b]	3,145,585	3,452,654	9.8%	3,576,200	3,707,000
Texas County[b]	16,419	20,107	22%	23,200	26,300
Region of influence	46,407	54,258	17%	57,229	60,285

	Percent change 2000 to 2010	2015	2020	Percent change 2010 to 2020	2025
Kansas[a]	4.7%	2,880,017	2,936,670	4.2%	2,988,382
Morton County[a]	2.0%	6,234	6,193	-0.56%	6,138
Seward County[a]	-0.07%	22,527	22,459	-0.41%	22,300
Stevens County[a]	-4.9%	5,123	5,030	-3.4%	4,967
Oklahoma[b]	7.4%	3,838,400	3,963,800	6.9%	4,081,400
Texas County[b]	31%	29,500	32,700	24%	36,000
Region of influence	11%	63,384	66,382	10%	69,405

a. Source: KDB 2008.
b. Source: Wallace and Bettis 2002.
c. Source: USCB 2000b.

Educational attainment levels in the region of influence vary widely. Approximately 81 percent of Stevens County, 82 percent of Morton County, and 64 percent of Steward County residents (age 25 and older) have at least a high school diploma. This compares with the Kansas state high school graduation rate of 86 percent. Approximately 72 percent of Texas County residents (age 25 and older) graduated high school, compared with about 82 percent for the state of Oklahoma. All four counties have a lower-than-state average percent of residents (age 25 and older) with a Bachelor's degree or higher. The national average (24.4 percent), the Kansas average (25.8 percent), and the Oklahoma average (25.8 percent) exceed the percent of Morton County (17.6 percent), Seward County (13.6 percent), Stevens County (17.5 percent) and Texas County (17.7 percent) residents with at least a Bachelor's degree (USCB 2009). Section 3.13 of this EIS discusses racial, ethnic, and income characteristic of the population in the region of influence.

Liberal, Kansas, and Guymon, Oklahoma, are the largest cities in the region of influence, with 2000 populations of 19,666 and 10,472, respectively (USCB 2000c). Liberal is in Seward County and Guymon is in Texas County. The largest city in Morton County is Elkhart, with a 2000 population of 2,233. The largest city in Stevens County is Hugoton, with a 2000 population of 3,708 (USCB 2000d). The largest city in each county is also the county's seat.

The population centers in the three Kansas counties and the single Oklahoma county in the region of influence are geographically distanced from one another, although there are established worker flow patterns among the centers. Table 3-23 lists the approximate distance between the population centers of each county. The socioeconomic discussion in Chapter 4 of this EIS establishes the economic linkage among the four counties.

Table 3-23. Approximate distance (in miles) between population centers in the region of influence.

Originating city	Elkhart, KS	Liberal, KS	Hugoton, KS	Guymon, OK
Elkhart, Kansas	NA	65 (105 km)	33 (53 km)	45 (72 km)
Liberal, Kansas	65 (105 km)	NA	33 (53 km)	41 (66 km)
Hugoton, Kansas	33 (53 km)	33 (53 km)	NA	41 (66 km)
Guymon, Oklahoma	45 (72 km)	41 (66 km)	41 (66 km)	NA

km = kilometers.
NA = not applicable.

3.10.2 COMMUNITY CHARACTERISTICS

3.10.2.1 Economy

All four counties in the socioeconomic region of influence are primarily rural in character. None of the counties is part of a *metropolitan statistical area* as defined by the U.S. Census Bureau; however, the Bureau categorizes Seward County as part of the Liberal, Kansas, *micro area* and Texas County as part of the Guymon, Oklahoma, micro area (USCB 2008b). A micro area consists of a core urban area (city) of a population of at least 10,000 (but less than 50,000), and consists of one or more counties that have a high degree of social and economic integration with the urban core. Metro and micro areas have more economic self-sufficiency than non-metro or micro areas. Both Kansas and Oklahoma are "right-to-work" states; workers are not required to join labor unions as a condition of employment (Greer n.d.). The U.S. Bureau of Economic Analysis reports employment data by industrial sector (as defined by the North American Industrial Classification System and other subcategories). Table 3-24 presents 2006 employment levels for the major employment sectors of each county and for the region of influence. The public or non-private, Government and Government Enterprises sector provides the highest percentage of employment in the region of influence, at approximately 17 percent, primarily in the Local Government subsector.

Table 3-24. Region of influence employment by sector[a], 2006.

Sector	Morton	Seward	Stevens	Texas	ROI total
Total employment	2,139	15,011	3,287	12,949	33,386
Wage and salary employment	1,377	12,576	2,184	9,955	26,092
Proprietors employment[b]	762	2,435	1,103	2,994	7,294
Farm proprietors employment	254	241	334	857	1,686
Nonfarm proprietors employment	508	2,194	769	2,137	5,608
Farm employment	300	518	552	1,870	3,240
Nonfarm employment	1,839	14,493	2,735	11,079	30,146
Private employment	1,153	12,008	1,929	9,230	24,320
Forestry, fishing, related activities, and other	(d)	(d)	143	193	NA
Mining	142	1,106	146	239	1,633
Utilities	(d)	(d)	(d)	93	NA
Construction	(d)	(d)	147	(d)	NA
Manufacturing	(d)	(d)	80	(d)	NA
Wholesale trade	64	(d)	(d)	347	NA
Retail trade	235	1,746	273	1,149	3,403
Transportation and warehousing	(d)	719	221	210	NA
Information	(d)	107	(d)	252	NA
Finance and insurance	69	305	(d)	348	NA
Real estate and rental and leasing	39	394	(d)	277	NA
Professional and technical services	52	(d)	123	380	NA
Management of companies and enterprises	0	(d)	0	35	NA
Administrative and waste services	55	432	72	352	911
Educational services	10	50	21	21	102
Health care and social assistance	47	730	(d)	425	NA
Arts, entertainment, and recreation	15	97	(d)	(d)	NA
Accommodation and food services	78	861	(d)	(d)	NA
Other services, except public administration[c]	(d)	875	185	701	NA
Government and government enterprises	686	2,485	806	1,849	5,826
Federal, civilian	24	107	27	77	235
Military	15	114	26	86	241
State and local	647	2,264	753	1,686	5,350
State government	22	85	27	389	523
Local government	625	2,179	726	1,297	4,827

Source: BEA 2008b.

a. The estimates of employment for 2001 to 2006 are based on the 2002 North American Industry Classification System.

b. Excludes limited partners.

c. “Other” consists of the number of jobs held by U.S. residents employed by international organizations and foreign embassies and consulates in the United States.

d. Not shown to avoid disclosure of confidential information, but the estimates for this item are included in the “total employment” figures for each county and the ROI.

NA = not available.

ROI = region of influence.

The private sector Retail Trade, Farming, and Mining subsectors employment (10 percent, 9.7 percent, and 4.9 percent, respectively) have a real presence in the region of influence. Morton County employment is dominated by the Retail Trade and Local Government subsectors; employment in Seward County is reliant on the Local Government, Retail Trade, and Mining subsectors; employment in Stevens County is centered around the Local Government, Retail trade, and Transportation and Warehousing subsectors; and Texas County employment has a large presence in the Local Government and Retail Trade subsectors. Only Stevens County has a disclosed employment in the construction industry, approximately 4.5 percent of the 3,287 jobs in the county.

The Bureau of Economic Analysis reports that in 2006, the average wage, for all industries, in the region of influence ranged from $28,560 in Stevens County to $32,345 in Morton County (BEA 2008c). Detailed information about wages in the construction industry for the counties in the region of influence is not available from the Bureau. Major employers in the region of influence provide a variety of goods and services for local, state, national, and international markets. As shown in Table 3-25, firms providing agricultural-related products and support services dominate the employment opportunities in the region of influence. Local governments, primarily the school districts, are also major employers.

Table 3-25. Major employers in the region of influence.

Company name	City	Number of employees	Primary SIC code description
Adams Hardfacing Co.	Guymon	105	Tillage tools
Anadarko Petroleum	Hugoton	51	Oil and gas producers
Applebee's Neighborhood Grill	Liberal	65	Restaurants
Behne Construction Co., Inc.	Guymon	55	Cement and construction
Best Well Svc Inc	Liberal	85	Oil field service
Branding Iron Restaurant	Liberal	60	Restaurants
Charlie Sand & Asphalt Co	Liberal	50	Sand and gravel (wholesale)
City of Guymon	Guymon	114	Government services
City Of Liberal	Liberal	50	Government offices: city, village, and township
Cottonwood Intermediate School	Liberal	75	Schools
Dillons	Liberal	145	Grocers: retail
Elkhart Cooperative Equity	Elkhart	70	Grain elevators
First National Bank	Liberal	50	Banks
Good Samaritan Society-Liberal	Liberal	50	Non-profit organizations
Great Plains Gas Compression	Hugoton	80	Gas-natural
Guymon Public Schools	Guymon	215	Education services
Halliburton Energy Svc	Liberal	110	Oil well services
Hitch Enterprises	Guymon	240	Feed lots
Hugoton Elementary School	Hugoton	97	Schools
Hugoton High School	Hugoton	53	Schools
J & R Sand Co Inc	Liberal	60	Excavating contractors
Liberal City Offices	Liberal	50	Government offices: city, village, and township
Liberal High School	Liberal	100	Schools
Liberal Inn	Liberal	60	Bars

Table 3-25. Major employers in the region of influence (continued).

Company name	City	Number of employees	Primary SIC code description
Liberal Police Dept	Liberal	50	Police departments
Liberal Police Investigations	Liberal	60	Police departments
Liberal Social & Rehab	Liberal	50	Government offices: state
Liberal Usd 480	Liberal	52	Schools
Memorial Hospital	Guymon	140	Medical services
Morton County Care Ctr	Elkhart	90	Nursing and convalescent homes
Morton County Hospital	Elkhart	180	Hospitals
Mosaic	Liberal	65	Rehabilitation services
National Beef Packing Co LLC	Liberal	2500	Meat packers (manufacturers)
National Carriers Inc	Liberal	100	Trucking-motor freight
National Guard	Liberal	70	State government: national security
Panhandle Telephone Coop., Inc.	Guymon	82	Communications
Phillips Petroleum	Guymon	96	Gas/oil
Pioneer Manor	Hugoton	95	Nursing and convalescent homes
Rolla High School	Rolla	50	Schools
Seaboard Farms of Oklahoma	Guymon	550	Pork production
Seward County Community Clg	Liberal	400	Schools: universities and colleges academic
Sonic Drive-In	Liberal	52	Restaurants
South Middle School	Liberal	50	Schools
Southwest Guidance Ctr	Liberal	50	Counseling services
Southwest Medical Ctr	Liberal	400	Hospitals
Southwestern Heights High Schl	Kismet	54	Schools
Stevens County Hospital	Hugoton	125	Hospitals
Sunflower Intermediate School	Liberal	65	Schools
Supreme Cattle Feeders LLC	Kismet	50	Livestock feeding
Texas County Courthouse	Guymon	55	Government services
Tri State Ag	Liberal	50	Newspapers (publishers/manufacturers)
Tri-County Electric Coop.	Hooker	50	Electrical services
Walmart	Liberal	220	Department stores
Wal-Mart	Guymon	98	Retail store
Walmart Supercenter	Liberal	250	Department stores
Washington Elem School Liberal	Liberal	55	Schools
Washington Grade School	Liberal	60	Schools
Weatherford	Liberal	61	Oil field specialties
West Middle School	Liberal	50	Schools
Wheatridge Park Care Ctr	Liberal	60	Convalescent homes
Wilkens Manufacturing Inc	Liberal	60	Trailer: manufacturers and designers

Sources: ODC 2000; Gray 2008.
SIC = Standard Industrial Classification (system).

Table 3-26 presents the average annual labor force data, including employment levels, number of unemployed individuals, and the annual unemployment rates from 2000 to 2007, as reported by the U.S. Bureau of Labor Statistics, for the region of influence. From 2000 to 2007, the average labor force shrank from 25,177 to 23,784 individuals, a 5.5-percent decrease. For the same period, average employment

Table 3-26. Employment characteristics, region of influence, 2000 to 2007.

Year	Period	Labor force	Employment (individuals)	Unemployment (individuals)	Unemployment rate
Morton County					
2000	Annual	1,743	1,693	50	2.9
2001	Annual	1,685	1,637	48	2.8
2002	Annual	1,609	1,558	51	3.2
2003	Annual	1,685	1,633	52	3.1
2004	Annual	1,686	1,631	55	3.3
2005	Annual	1,708	1,648	60	3.5
2006	Annual	1,730	1,682	48	2.8
2007	Annual	1,674	1,629	45	2.7
Seward County					
2000	Annual	10,369	10,053	316	3
2001	Annual	10,271	9,888	383	3.7
2002	Annual	10,362	9,943	419	4
2003	Annual	10,361	9,965	396	3.8
2004	Annual	10,474	10,037	437	4.2
2005	Annual	10,454	10,038	416	4
2006	Annual	10,596	10,245	351	3.3
2007	Annual	10,729	10,391	338	3.2
Stevens County					
2000	Annual	2,459	2,386	73	3
2001	Annual	2,311	2,229	82	3.5
2002	Annual	2,397	2,312	85	3.5
2003	Annual	2,333	2,252	81	3.5
2004	Annual	2,413	2,309	104	4.3
2005	Annual	2,404	2,305	99	4.1
2006	Annual	2,336	2,257	79	3.4
2007	Annual	2,216	2,142	74	3.3
Texas County					
2000	Annual	10,606	10,326	280	2.6
2001	Annual	10,613	10,322	291	2.7
2002	Annual	10,317	9,970	347	3.4
2003	Annual	10,494	10,121	373	3.6
2004	Annual	10,069	9,724	345	3.4
2005	Annual	9,355	9,013	342	3.7
2006	Annual	9,108	8,795	313	3.4
2007	Annual	9,165	8,846	319	3.5

Table 3-26. Employment characteristics, region of influence, 2000 to 2007 (continued).

Year	Period	Labor force	Employment (individuals)	Unemployment (individuals)	Unemployment rate
Region of Influence					
2000	Annual	25,177	24,458	719	2.9
2001	Annual	24,880	24,076	804	3.2
2002	Annual	24,685	23,783	902	3.7
2003	Annual	24,873	23,971	902	3.6
2004	Annual	24,642	23,701	941	3.8
2005	Annual	23,921	23,004	917	3.8
2006	Annual	23,770	22,979	791	3.3
2007	Annual	23,784	23,008	776	3.3
Region of influence percent change 2000 to 2007					
		-5.5	-5.9	NA	NA

Source: BLS 2009a.

a. As stated by the U. S. Bureau of Labor Statistics, these numbers reflect revised inputs, re-estimation, and new statewide controls.

NA = not applicable.

decreased 5.9 percent, from 24,458 to 23,008 workers. The region of influence average annual unemployment rate was 2.9 percent in 2000 and 3.3 percent in 2007 (most economists consider 4 to 6 percent to be an acceptable rate of unemployment). The average unemployment rate for the state of Kansas was 4.1 percent in 2007; for the state of Oklahoma, it was 4.3 percent (BLS 2009a). Annualized unemployment rates in 2008 were similar: 4.4 percent and 3.8 percent in Oklahoma. Unemployment rates in 2008 in the region of influence ranged from 2.7 percent in Texas County to 3.3 percent in Stevens County (BLS 2009b).

Per capita income is a useful means of comparing income among regions. The Bureau of Economic Analysis calculates per capita income by dividing the total personal income of an area by the area population. Table 3-27 presents per capita income data from 2000 to 2006 for the region of influence. From 2000 to 2006, per capita personal income grew in all four counties in the region of influence. In 2006, per capita personal income in the region of influence ranged from $24,408 in Morton County to $29,930 in Texas County. The weighted per capita income in the region of influence was $28,020. The per capita income in Kansas averaged $34,799 in 2006 while the per capita income in Oklahoma was $32,391 in the same year. The per capita income in the United States was $36,714 in 2006 (BEA 2008d).

Table 3-27. Per capita income, region of influence, 2000 to 2006.

Area/name	2000	2001	2002	2003	2004	2005	2006
Kansas	$27,691	$28,717	$28,980	$29,802	$30,995	$32,709	$34,799
Morton	$21,080	$20,092	$18,178	$20,707	$21,232	$24,816	$24,408
Seward	$22,092	$22,148	$22,287	$22,568	$23,872	$25,528	$26,791
Stevens	$25,625	$23,573	$21,965	$24,504	$27,407	$30,421	$28,289
Oklahoma	$24,409	$26,022	$25,872	$26,457	$28,444	$30,107	$32,391
Texas	$28,229	$28,071	$23,769	$25,754	$25,322	$27,651	$29,930

Source: BEA 2008d.

Note: Dollar values have not been adjusted for inflation.

3.10.2.2 Taxes

Several tax revenue categories would be affected by the construction and operations of the Proposed Action. These include income taxes on corporate profits, sale taxes on construction- and operations-related purchases, and purchases made by project-related workers; real property taxes related to the construction and operations of the plant; and real property taxes paid by incoming workers. The following subsection describes each of these types of tax in Kansas, Oklahoma, and, where applicable, each of counties and/or major cities in the region of influence.

Kansas has three personal income tax rates that range from 3.5 to 6.45 percent of taxable income. Retirement pensions from the military, civil service, and state and local government service are exempt from personal income tax assessments. The corporate income tax rate is a 4-percent flat rate tax. State sales tax is imposed on retail sales. The state sales tax rate is 5.3 percent with prescription drugs exempt from the tax. Local cities and counties may add an additional 3 percent. Morton County and Stevens County do not have a county sales tax; Seward County adds a 1.25-percent sales tax to the state tax. The City of Liberal, in Stevens County, has a 2-percent local sales tax; Elkhart, in Morton County, imposes a 1-percent local sales tax, as does Hugoton in Stevens County (KSTA n.d.a, n.d.b). Within the region of influence in Kansas, tangible property is assessed at the fair market value. The state inheritance and estate tax is in effect and applies through 2009, after which there will not be an estate tax (RLIC 2008).

Oklahoma has eight personal income tax rates that range from 0.5 to 5.55 percent (in 2008) of taxable income. The upper personal income tax rate will drop to 5.25 percent after 2008 (FTA 2008). Social security payments are exempt from income taxes, as are a portion of pension income from all sources. The corporate income rate is 6 percent flat rate tax. Texas County has a 1-percent personal income tax (TC n.d.). The state sales tax is 4.5 percent with prescription drugs exempt from the tax. Counties in the state may impose an additional sales tax of up to 2 percent. Cities may also impose a sales tax. The Texas County cities of Guymon, Hooker, and Tyrone have a 3-percent local sales tax, while Hardesty, Goodwell, and Texhoma have a 2-percent local sales tax (TC n.d.). Real property is assessed at an amount between 11 and 13 percent of the fair market value. There is no individual inheritance tax in the state, but there is a tax on the net estate of 0.5 to 10 percent (TC n.d.).

3.10.2.3 Housing

Table 3-28 presents housing characteristics in the region of influence. There were 19,825 housing units in the region of influence in 2000 and 20,304 units in 2007, an increase of 2.2 percent. In 2007, Seward County had 40 percent of the housing inventory in the region of influence, and Texas County had an additional 41 percent (USCB 2007). Of the housing units in 2000, 1,959 (9.9 percent) of the units were vacant. More than 120 vacant units were for seasonal, recreational, or occasional use. The region of influence housing inventory in 2000 included 4,119 mobile homes, approximately 21 percent of the inventory. In 2000, the median value of owner-occupied housing in the region of influence ranged from $67,700 in Morton County to $79,000 in Stevens County. The median monthly gross rent ranged from $413 in Morton County to $467 in Seward County.

Table 3-28. Housing characteristics, region of influence, 2007 and 2000.

Location	2007, total housing units[a]	2000, total housing units[b,c]	Percent change in housing inventory, 2000 to 2007[d]	2000, total occupied units[b]	2000, total vacant housing units[b]
Morton County	1,557	1,519	2.6	1,306	213
Seward County	8,120	8,027	0.9	7,419	608
Stevens County	2,297	2,265	1.5	1,988	277
Texas County	8,330	8,014	3.7	7,153	861
Region of influence	20,270	19,825	2.2	17,866	1,959

Location	2000, units for seasonal, recreational, or occasional use[b,e]	2000, mobile homes[f]	2000, median value of an owner-occupied unit[f]	2000, median monthly gross rent[f]
Morton County	19	272	$67,700	$413
Seward County	29	1,471	$72,400	$467
Stevens County	8	455	$79,000	$450
Texas County	66	1,921	$67,500	$450
Region of influence	122	4,119	NA	NA

a. Source: USCB 2007.
b. Source: USCB 2000e.
c. Detailed characteristics of housing for a more recent than 2000 period is not available from the U.S. Census Bureau for the region of influence counties.
d. Percent change in housing inventory is based on the U.S. Census Bureau revised 2000 count (19,870 units in the region of influence).
e. By definition, housing units classified as “For Seasonal, recreational, and occasional Use” are categorized as vacant.
f. Source: USCB 2000f.
NA = not available.

There are several motels, hotels, and bed and breakfast establishments in the Hugoton area; specifically, within a 50-mile (80-kilometer) radius of the Biorefinery Project site. The Hugoton Area Chamber of Commerce lists one bed and breakfast and four motels in the greater Hugoton area (HACC 2002). The Kansas Department of Commerce, Kansas Travel and Tourism Division lists eight additional motels and hotels in Kansas that fall within a 50-mile radius of the Project site (KDC n.d.). There are also at least eight motels in Texas County, Oklahoma (GCC n.d.).

3.10.2.4 Public Services

As described in the introduction to this section, Morton, Seward, and Stevens counties in Kansas and Texas County in Oklahoma have the greatest potential to experience socioeconomic impacts from the Proposed Action. Collectively, these four counties form the socioeconomic region of influence. The following material addresses community services in the region of influence; specifically, education, law enforcement, fire services, and medical services.

3.10.2.4.1 *Education*

There are 12 school districts that serve the region of influence. School districts in Kansas and Oklahoma often are not aligned with county boundaries, hence, information presented for the school systems in this discussion both include and exclude small geographical areas other than the region of influence. However, all referenced school districts are primarily within the region of influence. Figure 3-20 displays

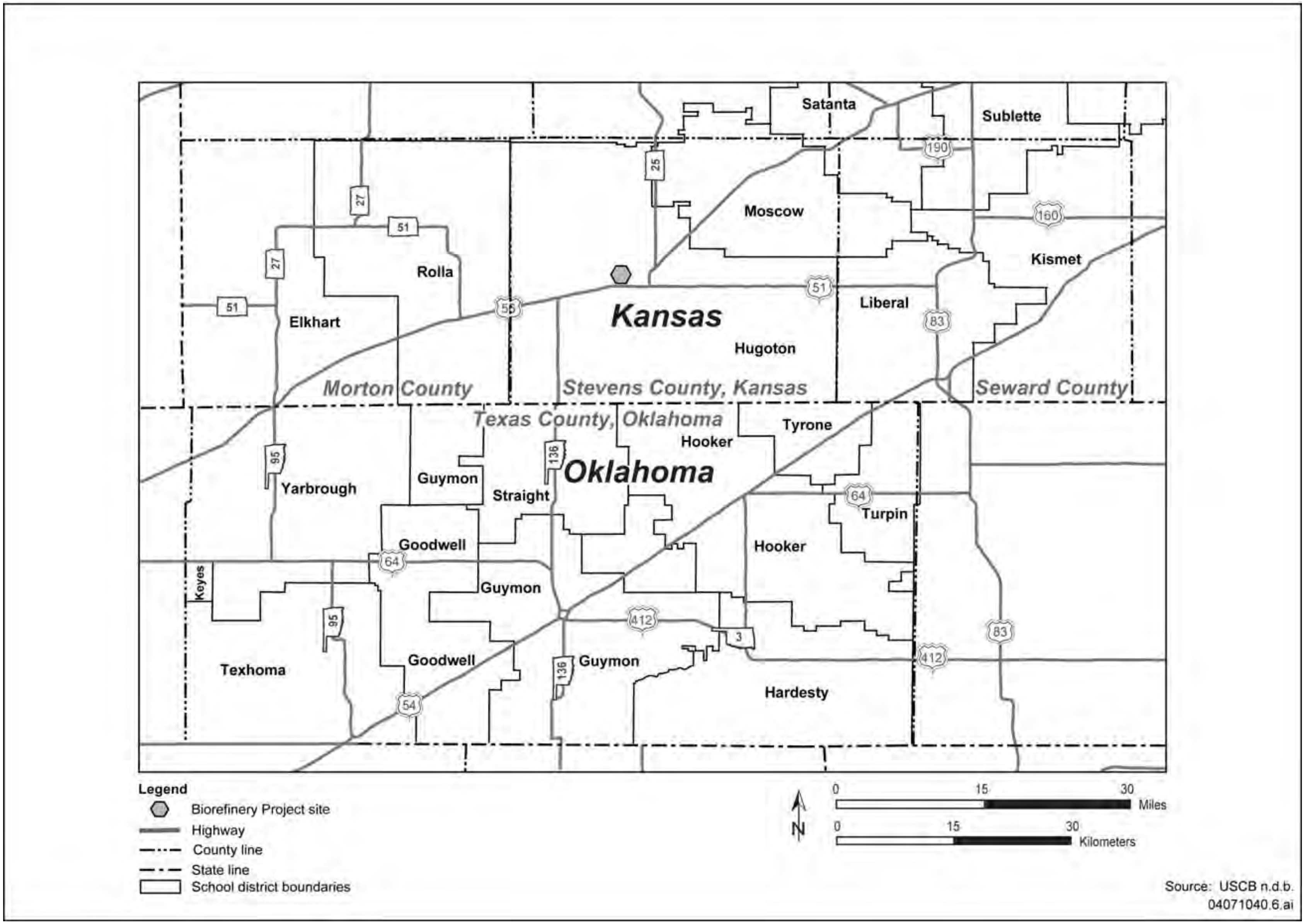

Figure 3-20. Boundaries of school districts in the 50-mile (80-kilometer) region of influence.

the boundaries of the school districts in the region of influence. School districts in both states serve students in multiple counties. Table 3-29 presents information about the school districts: the number of schools, enrollments, and student-to-teacher ratios for each of the districts in the region of influence. With respect to public school funding, Kansas has adopted a statute establishing a foundation for equalization of funding, per student, among school districts. K.S.A. 72-6410, “School District Finance and Quality Performance,” requires that the State of Kansas provide “base state aid per pupil” from the State’s general fund. Funding for local schools may be supplemented by the proceeds from a tax levied by a local school district. Public schools in Oklahoma are funded, in part, from a State allocation of general funds that is designed to lay a basis for equalized funding per student. The State allocation is supplemented on a district basis by local funds raised through real property (ad valorem) taxes and by federal funds (Melton 2008).

Table 3-29. Public school information, region of influence, 2005/2006 school year.

District name	Primary county	Total schools	Total students	Student/teacher ratio
Elkhart	Morton	4	717	11.7
Rolla	Morton	2	206	9.9
Kismet-Plains	Seward	3	738	13.8
Liberal	Seward	12	4,482	15.1
Hugoton Public Schools	Stevens	3	1,106	12.9
Moscow Public Schools	Stevens	2	236	11.3
Hooker	Texas	2	544	13.8
Guymon	Texas	8	2,357	13.6
Optima	Texas	1	56	11.2
Straight	Texas	1	42	6.3
Tyrone	Texas	2	229	12.0
Total		40	10,713	NA

Source: NCES 2006.
NA = not applicable.

There are three public institutions of higher learning within a 50-mile (80-kilometer) radius of the Biorefinery Project site (no private institutions). Table 3-30 presents institution characteristics and enrollments.

Table 3-30. Institutions of higher learning within the 50-mile (80-kilometer) region of influence.

College name	City, state	Level of offerings	Fall 2007 enrollment	Approximate distance from the Project site in miles (kilometers)
Seward County Community College	Liberal, Kansas	Associate's degrees	1,656	25 (40)
Southwest Kansas Technical College	Liberal, Kansas	Certificates	197	25 (40)
Oklahoma Panhandle State University	Goodwell, Oklahoma	Associate's and Bachelor's degrees	1,153	44 (71)

Source: NCES 2008.

3.10.2.4.2 *Law Enforcement*

Municipal police departments and county sheriff offices provide law enforcement services in the region of influence. The Morton County Sheriff Department provides services to the unincorporated portions of the County and in the city of Richfield. Elkhart has three full-time officers, and Rolla has a Chief Marshall (Holliday 2008). The Liberal Police Department has 42 sworn officers and 15 non-sworn personnel (Liberal n.d.). The Hugoton Police Department has two full-time and two part-time sworn officers in addition to non-sworn personnel (HPD 2008). The City of Guymon has 20 sworn officers and approximately 12 non-sworn personnel (GPD n.d.). Hooker has four officers (GPD n.d.).

The four counties in the region of influence are geographically large, approximately 4,134 square miles (10,700 square kilometers or 2,646,000 acres) (USCB 2008b) and the population centers are widely dispersed. The region's law enforcement personnel serve large areas and often must travel great distances to respond to calls. Table 3-23 (Section 3.10.1) provides approximate distance between select population centers. In the region of influence, as a whole, the ratio of residents to sworn officers is approximately 1,590 to 1. In 2005, the national average was 417 to 1. Table 3-31 summarizes information about law enforcement personnel in the region of influence.

Table 3-31. Law enforcement personnel in the region of influence.

Location	Total law enforcement employees	Total officers	Total civilians	Resident to officer ratio
Morton County	10	5	5	1,235
Seward County	36	11	25	2,055
Stevens County	18	9	9	584
Texas County	37	11	26	2,109
Region of influence	101	36	65	1,590

Source: FBI 2006.

3.10.2.4.3 *Fire Protection*

Table 3-32 provides fire protection service data for the region of influence. There are 12 fire stations, 30 active career firefighters, 108 active volunteer firefighters, and 42 firefighters that are paid per call in the region of influence. With the exception of the Liberal Fire Department, most of the region is served by active, but volunteer, firefighters. In 2006, the national residents-to-firefighter average was 262 to 1, essentially the same as the ratio in the region of influence, 285 to 1. As is the case with law enforcement personnel, firefighters in the region of influence must often travel great distances to respond to calls because of the large geographical area served.

Table 3-32. Fire protection services in the region of influence.

Fire department name	Fire headquarters city, state	County	Department type	Organization type	Stations	Active firefighter career	Active firefighter volunteer	Active firefighter paid per call
Elkhart Volunteer Fire Department	Elkhart, Kansas	Morton	Volunteer	Local	1	0	23	0
Liberal Fire Depart	Liberal, Kansas	Seward	Mostly career	Local	3	15	0	12
Stevens County Fire Department	Hugoton, Kansas	Stevens	Volunteer	Local	2	0	0	30
Goodwell Volunteer Fire Department	Goodwell, Oklahoma	Texas	Volunteer	Local	1	0	18	0
Guymon Fire Department	Guymon, Oklahoma	Texas	Mostly volunteer	Local	2	15	37	0
Hitch Fire Brigade	Guymon, Oklahoma	Texas	Volunteer	Private or industrial fire brigade	2	0	16	0
Texhoma Volunteer Fire Department	Texhoma, Oklahoma	Texas	Volunteer	Local	1	0	14	0
Region of influence					12	30	108	42

Source: USFA 2008.

3.10.2.4.4 *Medical Services*

Table 3-33 presents medical service data for the region of influence. There are two hospitals with 129 staffed beds in the region of influence. There are 69 practicing physicians, in all specialties, in the four-county region. The larger hospital and the majority of physicians are in the Liberal, Kansas, area. A comparison of the staffed beds to the daily census yields a utilization rate of 47 percent.

Table 3-33. Hospital and physician data in the region of influence.

County/hospital name	Hospital staffed beds[a]	Average daily census[a]	Outpatient visits	Hospital personnel[a]	Practicing physicians, all specialties[b]
Morton County	0	NA	NA	NA	8
Seward County					40
Southwest Medical Center	101	42	39,164	417	NA
Stevens County	0	NA	NA	NA	2
Texas County					19
Memorial Hospital of Texas County	28	18	16,859	184	NA
Region of influence totals	129	60	56,023	601	69

Note: There are no hospitals in Morton and Stevens counties.
a. Source: AHA 2006.
b. Source: AMA 2007.
NA = not applicable.

3.11 Cultural Resources

A Kansas State-approved archaeologist conducted a Phase I/II archaeological survey on a 160-acre (0.65-square kilometer) portion (northwest quarter of Section 17) of the east portion of the Biorefinery Project site and documented its findings in a report dated July 10, 2008 (K&K 2008). This report is appended as Appendix E of this EIS. The survey stated that “there are no Kansas State Historical Society-recorded sites located on or immediately adjacent to the proposed project or within an actionable radius of the project area.” The onsite survey, which included shovel-testing, concluded that, “No cultural materials were discovered during the investigation of the proposed Abengoa project site indicative of a prehistoric or early historic occupation.”

This EIS analyzes a 1-mile (1.6-kilometer) radius around the Biorefinery Project site and the site itself for potential impacts to cultural resources from noise, vibrations, visual degradation from agricultural-to-industrial use conversion, and/or increased traffic associated with the Proposed Action and Action Alternative. Based on a DOE review of published information, coordination with the State Historic Preservation Office, and the results of the Phase I/II investigation, no recorded sites are located within the Project site or adjacent lands (that is, within the 1-mile region of influence). No properties listed on the National Historic Register are within or on properties adjoining the Project site (K&K 2008).

DOE sought comment from American Indian tribes about the potential significance of the land at the Biorefinery Project site. DOE received no comments. However, DOE reviewed published information and did not note any tribal properties, cemeteries, or known burial sites within 1 mile (1.6 kilometers) of the Project site. Coordination with the Kansas State Historical Society indicated there are no sites on or immediately adjacent to the project area nor was there indication of a prehistoric or early historic occupation discovered during the onsite Phase I/II investigation (K&K 2008).

Because the Proposed Action includes offsite biomass storage sites, a second region of influence for cultural resources is a 30-mile (48-kilometer) radius around the Biorefinery Project site. Figure 3-21 shows the 30-mile region of influence and includes cemeteries, state historical properties listed or eligible for listing with the States of Kansas and Oklahoma, and buildings and sites listed or eligible for listing in the National Historic Register (KSHS n.d.a, n.d.b, n.d.c, 1912, 1998; OHS n.d.a, n.d.b, n.d.c).

3.11.1 PREHISTORIC AND EARLY HISTORIC OCCUPATION

3.11.1.1 Paleontological and Prehistoric

The fossil yields for most areas within and adjacent to the 30-mile (48-kilometer) region of influence are low, but quarries in the Cimarron National Grassland have yielded significant numbers of fossils. The Fullerton Gravel Pit has abundant Miocene tortoise and mammal bones as well as 3-toed horse and giant camel fossils.

Humans have been using areas within and adjacent to the 30-mile (48-kilometer) region of influence since the end of the Pleistocene glaciation period, approximately 10,000 years before present day. Archaeological evidence recovered from the southwestern portions of the state of Kansas, Oklahoma panhandle, and southeastern Colorado represents every major culture period of human occupation in North America. Cultural sequences for the state of Kansas vary according to the author and level of detail reported. Following is a generalized cultural sequence for the region of influence:

- Paleo-Indian Period, 10,000 to 7,000 BCE
- Archaic Period, 7,000 BCE to AD 1
- Early to Middle Ceramic Period, AD 1 to 1500
- Late Ceramic to Proto-historic Period, AD 1500 to 1800
- Historic Period AD, 1800 to present

Archaeological information for the areas within and adjacent to the 30-mile (48-kilometer) region of influence is relatively sparse during the Paleo-Indian Period, but the area likely was periodically used by nomadic hunter-gatherers that used spears to hunt large game, including mammoth and bison, and gathered seeds, roots, greens, and fruits of wild plants. The Archaic Period saw increased use of the area by American Indians and establishment of base camps.

Ceramic vessels were first used during the Early Ceramic Period. New food preparation and storage methods were developed as the ceramic periods progressed. The Middle and Late Ceramic periods saw the introduction and use of the bow and arrow as well as use of domesticated food crops. Domesticated food crops included maize (corn), beans, and squash. Some settlements were occupied for long periods during the Middle and Late Ceramic periods. Bison procurement and processing sites from the Middle Ceramic Period have been found in the Cimarron National Grassland.

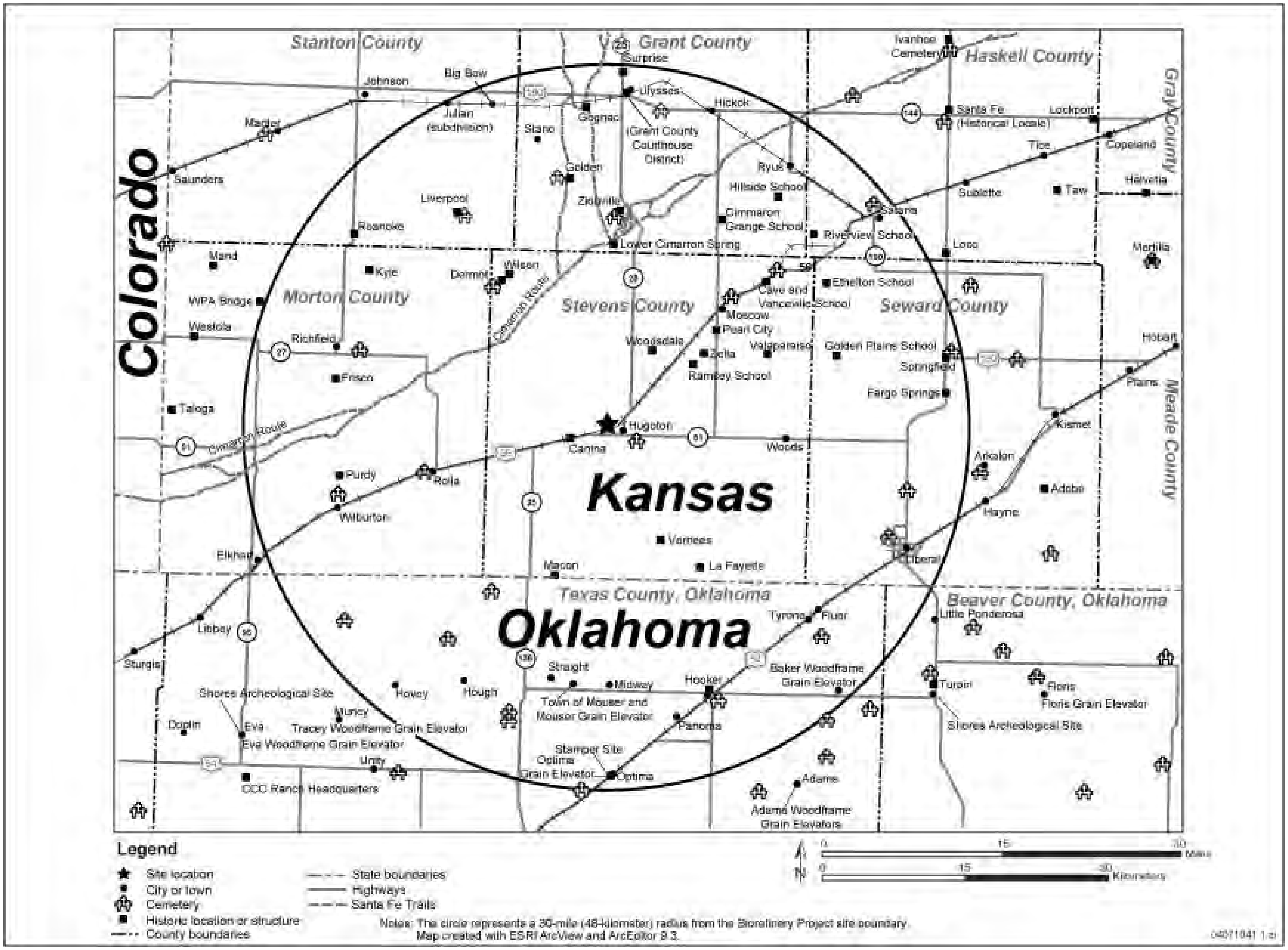

Figure 3-21. 30-mile (48-kilometer) region of influence with cultural resources sites.

3.11.1.2 Early to Late Historic

During the early Historic Period, the general area within and around the 30-mile (48-kilometer) region of influence was primarily occupied by the present-day Apache Tribe of Oklahoma, the Comanche Nation of Oklahoma, the Kiowa Tribe of Oklahoma, the Wichita and Affiliated Tribes, and the Pawnee Nation of Oklahoma. Other tribal groups known to have used areas within and adjacent to the 30-mile region of influence include Jicarilla, Arapaho, Cheyenne, and Ute.

Historic Europeans made excursions into the general area. The earliest known treks into and through the area were made by explorers Don Francisco Vásquez de Coronado in 1541 and Don Juan de Oñate in 1601. American Captain Zebulon Pike passed through the area in 1806. The Santa Fe Trail, which followed old American Indian travel routes, was open to European American travelers after Mexico gained its independence from Spain in 1821. These explorations were followed by trappers and traders from 1824 to 1831. Activity along the Santa Fe Trail continued to increase after the Mexican-American War ended in 1848 and after the American Civil War ended in 1865.

European American hunters decimated the bison herds and introduced diseases such as cholera and smallpox, which decreased the area's American Indian populations. The *Homestead Act of 1862* encouraged additional European-American settlement and in the 1860s and 1870s cattlemen began moving into the area. Stevens County was organized August 1886 and Hugoton was made the county seat. A railroad to Liberal was present by 1910 and a railroad line was constructed across Stevens County in 1912.

Droughts between 1900 and 1920 forced many from the region. There were four consecutive years of drought from 1933 to 1936 that helped create the "Dust Bowl." The Dust Bowl, in combination with the Great Depression, forced many people from the region, and the population took several decades to recover.

3.11.1.3 Santa Fe Trail

The Santa Fe Trail was the most important route to the West from Franklin, Missouri, to Santa Fe, New Mexico, before the era of the railroads (SFTA n.d.a). Trail use began about 1821 by traders, freighters, and the military. The trail was surveyed by the U.S. Government in 1825 and was used until the 1870s to transport textiles and manufactured goods from Missouri to Santa Fe, and return trips to Missouri with silver coins, pelts, and mules. The trail is approximately 750 miles (1,200 kilometers) long, of which two-thirds is in the state of Kansas. Portions of the trail are in the region of influence (Figure 3-21). In 1987, the trail was designated a National Historic Trail. Relatively undisturbed portions of the trail can be found in the Cimarron National Grassland.

The Jornado portion of the Santa Fe Trail lies in the northeast portion of the region of influence. The Jornado portion was one of the dry routes to Santa Fe and ran from the present day city of Cimarron to the Cimarron River. The Jornado portion was part of the Cimarron cutoff, which was shorter than other alternate routes, and traveled across a 60-mile (100-kilometer) stretch of desert with no source of water (SFTA n.d.b).

3.11.2 RESOURCES OF LOCAL SIGNIFICANCE

Stevens County Gas & Historical Museum is located in the southeast portion of Hugoton, Kansas. The half-block complex has restored buildings that include an 1887 one-room school house; an 1887 house; Hugoton's first jail house; the 1913 Santa Fe Hugoton Train Depot; and a 1905 Methodist church, which was the second church in Hugoton. The museum also has horse-drawn machinery, natural-gas displays from the 1930s, automobiles and tractors from the 1920s and 1930s, and the original bell tower from the courthouse.

3.12 Health and Safety

This section describes the region of influence and the representative health and safety statistics for a project of this type and size. Section 3.12.1 describes the region of influence for heath and safety; Section 3.12.2 describes industrial health and safety, focusing on occupational and worker hazards; and Section 3.12.3 describes public health and safety, focusing on hazards that could affect the communities near the Proposed Action.

3.12.1 REGION OF INFLUENCE

The region of influence for the analysis of human health and safety associated with the Proposed Action and the Action Alternative is different for industrial health and safety than it is for public health and safety. Industrial health and safety has a region of influence that incorporates the actual work locations, both on- and offsite. Public health and safety has a region of influence that extends beyond the work locations to include those areas where the public might be affected by the Proposed Action and Action Alternative.

3.12.2 INDUSTRIAL HEALTH AND SAFETY

Industrial health and safety is concerned with occupational and worker hazards during routine operations. The U.S. Department of Labor, Bureau of Labor Statistics, maintains statistics on workplace injuries, illnesses, and fatalities. These statistics consider the potential for *total recordable cases*; *days away from work*, *days of restricted work activity or job transfer*; and worker fatalities in the work environment. The *incidence rates* (cases per 100 full-time workers for nonfatality statistics and cases per 100,000 full-time workers for fatality statistics) maintained by the Bureau of Labor Statistics are calculated separately for different industries based on the reported health and safety cases for that particular industry. The health and safety incident categories are defined as follows:

- Total recordable cases. The total number of work-related deaths, illnesses, or injuries that result in the loss of consciousness, days away from work, restricted work activity or job transfer, or required medical treatment beyond first aid.

- Days away from work, or days of restricted work activity or job transfer. Cases that involve days away from work, or days of restricted activity or job transfer, or both.

- Worker fatality. Cases that involve the death of a worker.

In order to minimize the effect of industrial health and safety hazards, industries must comply with all applicable regulations that relate to industrial health and safety. A facility-specific Process Safety

Management Plan is written, as necessary, to comply with the Occupational Safety and Health Administration "Process Safety Management of Highly Hazardous Chemicals" regulation (29 CFR 1910.119). This regulation contains requirements for preventing or minimizing the consequences of catastrophic releases of toxic chemicals that could result in toxic, fire, or explosion hazards. A facility-specific Risk Management Plan is written, as necessary, to comply with the EPA *Clean Air Act*, Chemical Accident Prevention Provisions (40 CFR Part 68). The goal of the Risk Management Plan is to prevent accidental releases of substances that could cause serious harm to individuals or the environment.

3.12.2.1 Construction

Industrial health and safety hazards during construction would include, but are not limited to falls, being struck by objects or equipment, electric shocks, and cuts and abrasions. The Bureau of Labor Statistics incidence rates for the construction industry can be used to calculate a conservative estimate of the health and safety impacts from construction projects. Table 3-34 shows the incidence rates for the construction industry.

Table 3-34. Health and safety incidence rates for construction and operations of biorefinery and ethyl alcohol manufacturing plants and cogeneration facilities.

Industry	Rate of total recordable cases per 100 FTEs[a]	Rate of days away from work cases per 100 FTEs[a]	Rate of fatalities per 100,000 FTEs[b]
Construction	5.4	2.8	10.3
Operations[c]			
Ethyl alcohol manufacturing	6.7	1.9	–
Post-harvest crop activities	6.8	3.5	–
Other electric power generation	4.7	2.9	–
Chemical manufacturing	–	–	2.0
Support activities for agriculture	–	–	20.6
Utilities	–	–	3.9

a. Bureau of Labor Statistics incidence rates from the year 2007: BLS 2008a.
b. Bureau of Labor Statistics incidence rates from the year 2007: BLS 2008b.
c. The Bureau of Labor Statistics incidence rates for the industry categories "Ethyl Alcohol Manufacturing," "Post-harvest Crop Activities," and "Other Electric Power Generation" contain rates for only total recordable cases and days away from work. The statistics for these three industries do not list incidence rates for fatalities. Fatality incidence rates are listed for the industry categories "Chemical Manufacturing," "Support Activities for Agriculture," and "Utilities."
FTE = full-time equivalent worker year (2,000 hours).

3.12.2.2 Operations

Industrial health and safety hazards during operations of biorefinery and ethyl alcohol manufacturing plants in the United States include, but are not limited to toxic chemical exposure, burns, explosions, tank ruptures, machinery accidents, and falls. Nationally, approximately 190 ethanol production facilities currently have an operating capacity of over 10 billion gallons (38 billion liters) of ethanol per year, with another 2 billion gallons (7.6 billion liters) of capacity under construction (RFA 2009). These existing ethanol plants provide information for the Bureau of Labor Statistics to calculate incidence rates for ethyl alcohol manufacturing. The Bureau of Labor Statistics has also calculated incidence rates for the operation of electric power generation facilities other than hydroelectric, fossil fuel, and nuclear (defined as "Other Electric Power Generation"). Table 3-34 shows the incidence rates for ethyl alcohol manufacturing operations and electric power generation.

3.12.3 PUBLIC HEALTH AND SAFETY

Public health and safety is concerned with potential exposure of the general public to physical hazards and hazardous chemicals resulting from construction and routine operations related to a biorefinery and ethyl alcohol manufacturing plant. The types of hazards that could affect public health and safety at locations away from the work site include increased traffic, increased concentrations of particulate matter and other criteria air pollutants, additional noise, and offsite exposure due to release of chemicals. Sections 3.2, 3.8, and 3.9.2 of this EIS discuss the affected environments of air quality, transportation, and noise, respectively.

Section 4.11 of this EIS discusses the impacts related to public health and safety during routine operations. Section 4.12 discusses the impacts related to facility accidents and sabotage, as opposed to routine operations.

3.13 Environmental Justice

Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, directs federal agencies to "promote nondiscrimination in Federal programs substantially affecting human health and the environment, and provide *minority* and *low-income* communities access to public information on, and an opportunity for public participation in, matters relating to human health or the environment." Executive Order 12898 also directs agencies to identify and consider disproportionately high and adverse human health or environmental impacts of their actions on minority and low-income communities and American Indian tribes, as well as provide opportunities for community input to the *National Environmental Policy Act*, as amended (NEPA; 42 U.S.C. 4321 et seq.) process, which includes input on potential effects and *mitigation* measures. Executive Order 12898 and its associated implementing guidance establish the framework for characterization of the affected environment for environmental justice.

ENVIRONMENTAL JUSTICE TERMS

Minority:
Hispanic, Black, Asian/Pacific Islander, American Indian/Eskimo, Aleut, and other non-White person.

Low income:
Below the poverty level as defined by the U.S. Bureau of the Census.

This section describes the minority and low-income populations in the region of influence for the Biorefinery Project site that could experience disproportionately high and adverse human health or environmental effects from the Proposed Action. DOE considered census data for minority and low-income populations for the smallest census areas for which information was available: block data for identification of minority areas and block group data for low-income areas. Because the region of influence is sparsely populated, DOE used block group data to define both minority and low-income communities. This EIS uses minority and poverty data from the 2000 Census.

The regions of influence for environmental justice in this EIS vary with resource area and correspond to the region of influence for each resource area. The largest region of influence for any resource area is a 50-mile (80-kilometer) radius around the Biorefinery Project site. Counties within the 50-mile region of influence are Stevens, Seward, Morton, Stanton, Hamilton, Grant, Haskell, Kerny, Finney, Gray and Meade in Kansas; Texas, Beaver, and Cimarron in Oklahoma; and Baca County in Colorado. DOE analyzed U.S. Bureau of the Census block group data for minority populations and low-income populations partly or completely within the regions of influence where the percentages of minority or low-income residents were meaningfully greater than average (Table 3-35). For this EIS, meaningfully greater than average is considered 10 percent greater than average. Because the majority of the regions of influence are in Kansas, the average minority and low-income populations of Kansas were used to define communities within the regions of influence that were meaningfully greater than average. In the 2000 Census, minority persons comprised 14 percent of the population, and about 10 percent of the people of Kansas were living in poverty. For this EIS, census blocks that are greater than 24 percent minority are considered communities with minority populations meaningfully greater than average. Census block groups that are greater than 20-percent low-income are considered communities with low-income populations meaningfully greater than average.

Table 3-35. Census block group data for minority and low-income populations within the 50-mile (80-kilometer) region of influence.

County	Population	Percent minority population	Percent population living in poverty	Block groups	Block groups with a minority population greater than 24 percent	Block groups with 20 percent of the population below poverty level
Kansas	2,688,000	14	10	NA	NA	NA
Stevens	5,463	17	10	5	1	0
Seward	22,510	35	17	17	10	6
Morton	3,496	12	10.5	3	0	0
Stanton	2,406	16	15	2	0	0
Grant	7,909	23	10	7	3	0
Haskell	4,307	15	12	5	0	0
Hamilton	2,670	18	16	2	1	0
Kearny	4,531	20	12	3	0	0
Finney[a]	4,562	14	13	3	0	0
Gray[a]	1,377	8	10.5	2	0	0
Meade[a]	1,930	14	13	2	0	0
Oklahoma	3,450,000	24	15	NA	NA	NA
Texas	20,107	23	14	20	4	3
Beaver[a]	3,555	8	10.5	4	0	0
Cimarron[a]	833	7	15	1	0	0
Colorado	4,301,261	17	9.3	NA	NA	NA
Baca[a]	616	4	14	1	0	0

a. Reports data from the block groups that fall partially or completely within 50 miles (80 kilometers) of the biorefinery project site.
NA = not applicable.

Figure 3-22 graphically presents census block groups within the 50-mile (80-kilometer) region of influence, where the minority population exceeded 24 percent in 2000. Nineteen block groups exceeded the minority population density criterion of 24 percent. Figure 3-23 graphically presents census block groups within the 50-mile radius of the site where the population living in poverty was greater than 20 percent of the whole population in that block group. Nine block groups exceeded the population density threshold of 20 percent. The poverty threshold in the 2000 Census for a family of four was a 1999 income of $17,603.

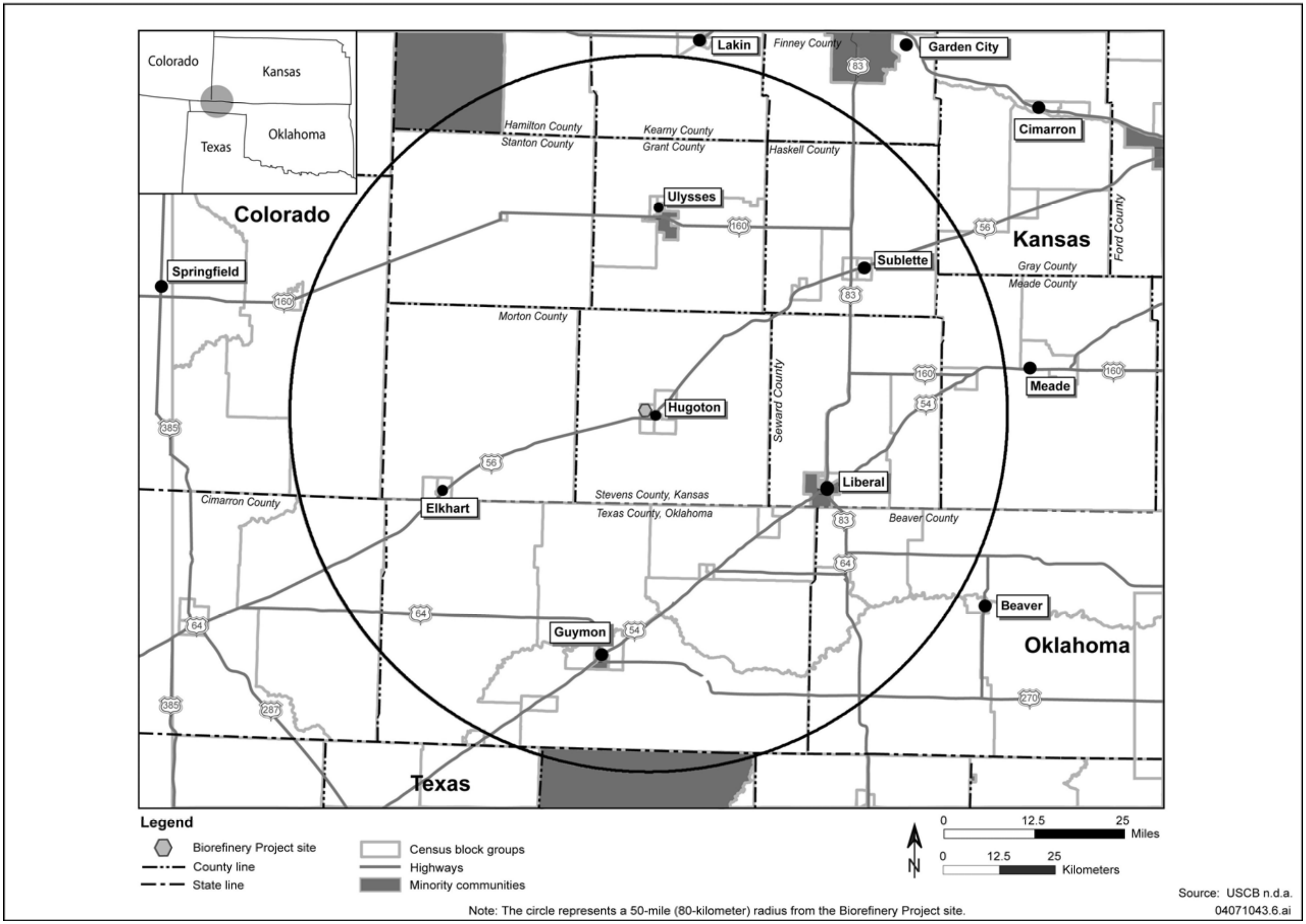

Figure 3-22. Graphical representation of census block groups within the 50-mile (80-kilometer) region of influence where the minority population exceeded 24 percent in 2000.

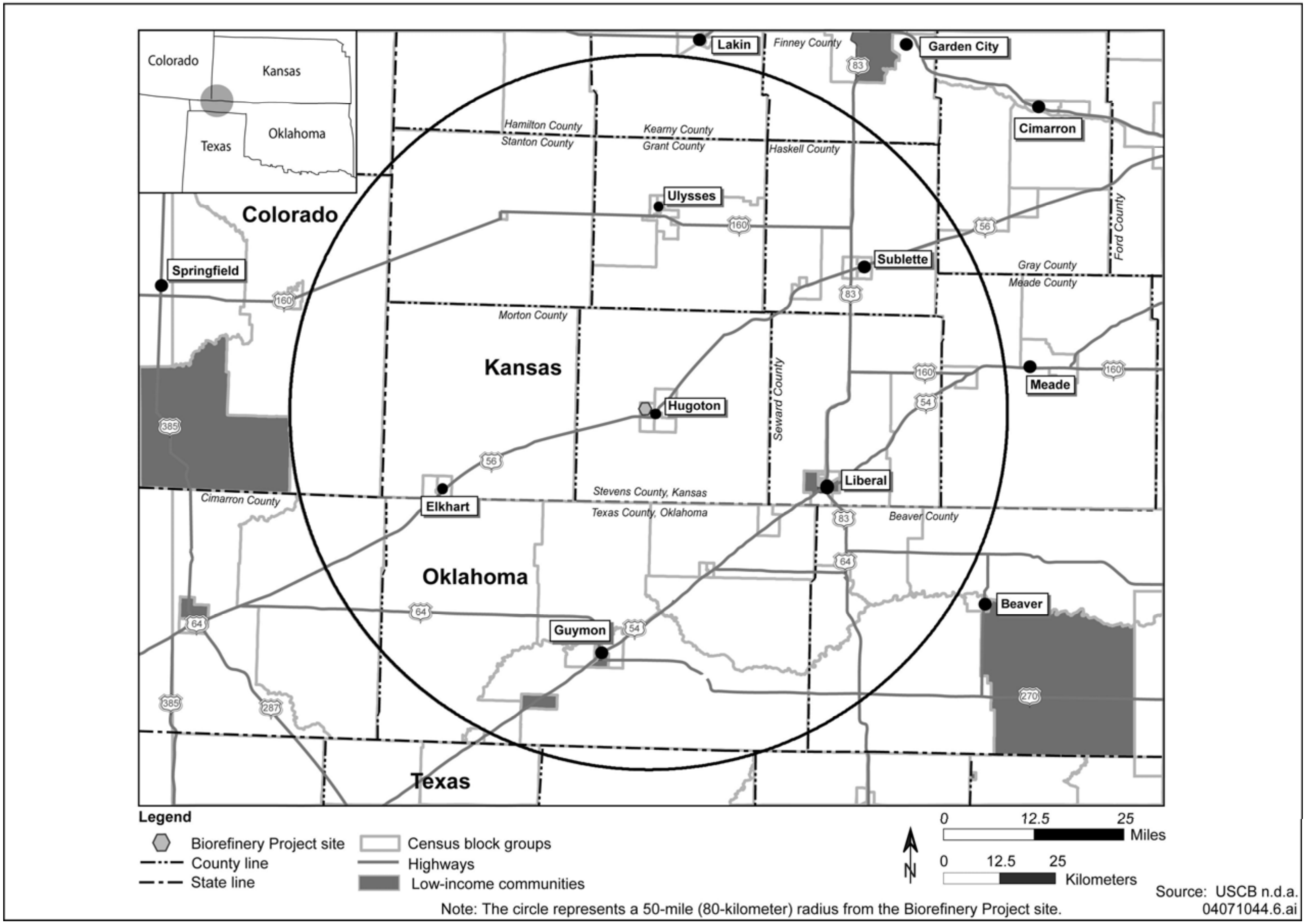

Figure 3-23. Graphical representation of census block groups within the 50-mile (80-kilometer) region of influence where the population living in poverty was greater than 20 percent of the whole population in that block group.

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Chapter 4

Environmental Impacts

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4. ENVIRONMENTAL IMPACTS

The U.S. Department of Energy (DOE or the Department) and the U.S. Department of Agriculture (USDA) evaluated potential impacts associated with the construction and operation of the proposed biomass-to-ethanol and energy facilities described in Chapter 2. This chapter describes the methodology used to estimate the impacts for both the Proposed Action and the Action Alternative to the *affected environment* presented in Chapter 3 for 13 resource and subject areas. The material presents the *best management practices* that would be used during construction and operations and describes approaches that could *mitigate* impacts. The No-Action Alternative is also discussed in this chapter. For this alternative, DOE assumes that Abengoa Bioenergy would not build the *biorefinery*.

Impacts are discussed by resource and subject area for the resource-specific *region of influence* defined in Chapter 3. The potential impacts associated with the Proposed Action are discussed first, followed by the potential impacts associated with the Action Alternative. Impacts associated with the No-Action Alternative are summarized in one section at the end of this chapter.

4.1 Land Use

This section describes the environmental impacts to land use within the region of influence for the Proposed Action (Section 4.1.1) and the Action Alternative (Section 4.1.2). An impact summary is provided in Section 4.1.3.

4.1.1 PROPOSED ACTION

As described in Section 3.1, the environmental impacts analysis is organized into the three geographical areas: impacts within 50 miles (80 kilometers) of the *Biorefinery Project site* (Section 4.1.1.1), impacts within 1 mile (1.6 kilometers) of the Project site (Section 4.1.1.2), and impacts on the Project site (Section 4.1.1.3).

4.1.1.1 Impacts within 50 Miles (80 kilometers) of the Biorefinery Project Site

Potential land use impacts from *biomass* procurement are primarily a result of *biorefinery* demand for biomass (Section 4.1.1.1.1) and biomass removal (Section 4.1.1.1.2). Biorefinery demand for the biomass, or the opportunity for producers to sell biomass, has the potential to impact land use by changing what is produced within the region of influence. Biomass removal has the potential to impact the land from which it is removed and change how the land is managed. Following the biomass demand and removal impact analysis, this section evaluates impacts related to offsite storage of biomass (Section 4.1.1.1.3), conservation programs (Section 4.1.1.1.4), *prime farmland* and *highly erodible land* (Section 4.1.1.1.5), and public lands (Section 4.1.1.1.6).

4.1.1.1.1 *Biomass Demand*

Potential land use change induced by biomass demand is an important consideration because certain land use changes could be considered an adverse impact, while other land use changes could be considered beneficial. For example, the conversion of native *grassland* or other land in less-intensive use to cropland could be considered an adverse impact because it could reduce wildlife habitat and increase delivery of sediment, nutrients, and pesticides to bodies of water (BRDB 2008). This type of land use change could also result in increased *greenhouse gas* emissions. (Section 4.2.1.3 discusses impacts related to greenhouse gas.) Conversely, converting cropland to a less-intensive land use could be considered a beneficial impact to natural resources. Such change in the intensity of land use is considered a change in land use type. A change in how the land is managed within the same land use type (growing corn instead of grain sorghum, for example) is considered a change in land use management. In general, changes in land use management within the same land use type are expected to involve minimal environmental changes.

In this section, the Department evaluates potential biomass demand-related land use changes by evaluating the anticipated biorefinery demand for biomass relative to the amount of biomass available within the region of influence. This evaluation considers the proposed feedstock procurement system, which specifies the type and amount of biomass targeted by Abengoa Bioenergy and the contractual method that would be used to procure these *feedstocks*. The following paragraphs describe the feedstock procurement system and are followed by the biomass demand impact analysis. The biomass feedstocks are organized by crop *residues*, switchgrass, and biomass from *Conservation Reserve Program* (CRP) acreage.

The biorefinery would use approximately 2,500 dry short tons (2,300 dry metric tons) per day of *lignocellulosic feedstock* (Roach 2009a). Operating 350 days per year, this equates to 875,000 dry short tons (793,800 dry metric tons) per year (Roach 2009a). Table 4-1 shows the anticipated types and proportion of *lignocellulosic feedstocks* for acquisition. For this Abengoa Biorefinery Project EIS, the term “ton” refers to U.S. short tons.

Table 4-1. Anticipated initial feedstock demand.

Feedstock	Percent of feedstock	dry tons per year	dry metric tons per year
Irrigated corn stover	82	717,500	650,900
Grain sorghum stover	7	61,300	55,570
Irrigated wheat straw	7	61,300	55,570
Switchgrass/CRP[a]	4	35,000	31,750
Total[b]	100	875,000	793,800

Source: Roach 2009a.
a. Biomass from CRP acreage.
b. Totals might differ from sums due to rounding.
CRP = Conservation Reserve Program.

Abengoa Bioenergy has drafted a standard biomass purchase contract for use with biomass producers supplying feedstock to the biorefinery (Roach 2009b). The draft biomass purchase contract is a 10-year contract and includes commitment and annual reservation fees paid to contracted biomass producers on a per-acre basis upon startup of the biorefinery. Biomass would be purchased on a dry ton basis. Abengoa would not be obligated to purchase the biomass, and the biomass producer would not be obligated to plant a particular crop in any given year. The relevance of the biomass purchase contract as it relates to each type of biomass feedstock is discussed in the following analysis.

Crop Residue

Using 2003 to 2007 crop production statistics from the USDA National Agricultural Statistics Service for the seven nearby counties (Section 3.1.1.2), Abengoa Bioenergy estimated a combined annual production of 3.4 million dry short tons (3.1 million dry metric tons) of corn, grain sorghum, and wheat residue (Roach 2009c). If extrapolated to represent the entire region of influence, 4.5 million dry tons (4.1

million dry metric tons) of crop residue could be produced annually. Using the same production data but different conversion factors and methods, the Department's estimates range from 4.2 to 4.7 million dry tons (3.8 to 4.3 million dry metric tons) of annual crop residue from corn, grain sorghum, and wheat within the region of influence. Based on these results, DOE concludes that 4.5 million dry tons (4.1 million dry metric tons) is a reasonable estimate of annual corn, grain sorghum, and wheat residue production within the region of influence. Comparatively, the total anticipated feedstock demand is 875,000 dry tons (793,800 dry metric tons) per year (Table 4-1). For reasons discussed below, some of this crop residue is not available for harvesting. In addition, the 4.5-million-dry-ton estimate includes crop residue from all corn and wheat production, but Abengoa is only targeting irrigated corn and wheat acreage (Table 4-1). Nevertheless, it is important to understand the magnitude of the excess crop residue supply as a safety factor to ensure that the biorefinery would have adequate feedstock available despite any significant changes in crop production.

Harvesting all crop residue from a given field is generally not feasible or desirable. The amount of residue collected is limited by equipment inefficiencies. *Soil sustainability* concerns also limit the amount of residue that should be removed. In general, soil sustainability refers to the amount of residue that can be removed without adversely impacting soil productivity. Section 4.1.1.1.2 further discusses residue removal rate impacts and soil sustainability. For this analysis, DOE used the sustainable removal rate of 50 percent reported by Abengoa Bioenergy (Roach 2009c) to estimate the amount of crop residue that could be harvested, as follows:

- Approximately 950,000 dry tons (860,000 dry metric tons) of irrigated corn residue,
- Approximately 240,000 dry tons (220,000 dry metric tons) of grain sorghum residue, and
- Approximately 280,000 dry tons (250,000 dry metric tons) of irrigated wheat residue.

Combined, annual crop residue from these three targeted feedstocks is approximately 1.5 million dry tons (1.4 million dry metric tons). Using these estimates, total crop residue demand from the biorefinery would represent about 55 percent of targeted crop residues that could be sustainably removed. Likewise, biorefinery demand for irrigated corn residue would be about 75 percent of the amount that could be sustainably removed. In other words, to meet biorefinery demand for irrigated corn residue, about half the corn residue would be removed from about 75 percent of the irrigated corn acreage within the region of influence. Demand for grain sorghum and irrigated wheat residue would be less then 20 percent of the sustainable amount available.

This analysis is from a regional perspective using average production data, average conversion factors, and average removal rates. In order to minimize feedstock procurement costs, the Department expects that Abengoa Bioenergy would target highly productive acreage capable of sustaining higher removal rates. Further, substantial precedent for future productivity growth exists (BRDB 2008), meaning that more crop residue is expected to be available in the future. Relative to the above estimates, these additional considerations are expected to reduce both the percentage of total residue and the acreage needed for crop residue procurement.

Based on this analysis, DOE concludes the following:

- Considering the excess of crop residue, the biorefinery would have flexibility in selecting feedstock procurement acreage,

- This flexibility would allow the biorefinery to target productive acreage capable of sustaining higher removal rates in order to reduce procurement costs,
- This economically induced procurement system would tend to target land already used for crop production and not target land in less-intensive use, and
- Since harvestable, targeted crop residues exceed anticipated biorefinery demand, supply and demand principals indicate there would be no incentive to produce more crop residue for the purpose of meeting demand.

The Department also considered how the biomass purchase contract in conjunction with crop residue demand could impact land use. Preliminary information in the draft biomass purchase contract indicates the value of the biomass is an order of magnitude lower than the value of the grain. There are input costs associated with grain production and mainly *opportunity costs* associated with crop residues (Section 4.1.1.1.2), but the value comparison illustrates that crop residue is a *byproduct* and producers would not likely change land use based solely on the opportunity to sell the residue. Further, because it would pay for the rights to the contracted acreage, Abengoa would be expected to contract only as much acreage as needed to reasonably ensure biorefinery operations. Therefore, the biomass purchase contract would provide an incentive for contracted producers to keep cropland as cropland and would have no apparent impact on land that is not contracted.

In summary, DOE anticipates the biorefinery crop residue demand would have a negligible impact on changes in land use type because there would be no incentive to alter land use type for the purpose of meeting demand.

Switchgrass

Switchgrass is not currently being produced commercially within the region of influence and would not likely be produced commercially unless the biorefinery is constructed. However, the Oklahoma Bioenergy Center began planting 1,000 acres (4 square kilometers) of switchgrass near Guymon, Oklahoma, in June 2008 (HPJ 2008). The project is intended to provide academia and industry with a production-scale switchgrass demonstration field for research purposes. Biomass from the switchgrass demonstration field would be available as a biomass feedstock to the biorefinery.

The previous crop residue analysis demonstrates that if switchgrass remained largely unavailable within the region of influence, the relatively small amount of switchgrass included in the anticipated feedstock demand (Table 4-1) could easily be met with the excess supply of crop residue. Therefore, DOE anticipates that if switchgrass was not available, there would still be no incentive to change land use for the purpose of meeting demand.

Because switchgrass is not produced commercially within the region of influence, demand for switchgrass or the opportunity to sell switchgrass has the potential to change land use to switchgrass production. Considering the relatively small amount of switchgrass included in the anticipated feedstock demand (Table 4-1), land use changes associated with increased switchgrass acreage would be minor relative to the amount of land within the region of influence. However, Abengoa Bioenergy anticipates that over time, switchgrass would replace corn residue as the primary feedstock. Factors working against switchgrass as the primary feedstock include lack of *crop rotation* potential; farmers' aversion to growing new crops for which they lack information and experience; yield uncertainty; the 2- to 3-year lag (relative to annual crops) before switchgrass becomes economically productive; and the potential to be a weedy or invasive species (BRDB 2008). Uncertainties in weighing the negative and positive factors of switchgrass adoption make estimating future switchgrass production within the region of influence unreliable. Abengoa would control the amount of switchgrass production to some extent by use of the biomass purchase contracts. Because large-scale production of switchgrass is not yet established within the region of influence, Abengoa would initially procure most of the feedstock through 10-year crop residue contracts. Therefore, it would not be logical for Abengoa to then enter into contracts representing a significant amount of switchgrass acreage and thereby overpay for biomass rights. For these reasons, DOE does not expect a sudden expansion of switchgrass production within the region of influence.

Since conversion of at least some land to switchgrass production is likely, but the magnitude is unknown, DOE can only evaluate the anticipated implications of increased switchgrass production. Because switchgrass can be cultivated on lands that are economically marginal for growing field crops or with otherwise low-valued economic uses (BRDB 2008), a change in land use from annual cropland to perennial switchgrass would likely be limited to *marginal cropland*. In addition, energy crops such as switchgrass are expected to compete more with pasture than cropland (BRDB 2008), so productive cropland is expected to remain in crop production. The extent to which switchgrass would replace pasture or marginal cropland is largely a function of economics. At a forecasted price for switchgrass, some conventional crop production could be used more profitably for switchgrass production (Andress 2002). Because it is native, switchgrass is resistant to many pests and plant diseases and is capable of producing high yields with relatively low applications of water, fertilizer, and pesticides. Switchgrass also establishes deep roots that store carbon in the soil (BRDB 2008). Therefore, in terms of the environment, a change in land use type from annual crops to switchgrass production on marginal land is considered a beneficial impact. A change in land use from perennially vegetated land such as pasture or hay would be expected to involve minimal environmental changes.

The opportunity cost of increased switchgrass production, aside from annual crop production on marginal land, is likely a reduction in the availability of other types of livestock forage. Livestock producers that control the land that supports their livestock feed demand would remain in control of the needed forage production. Therefore, the opportunity cost would likely only impact livestock producers that rely on land that is not in their control for livestock feed. DOE does not consider such an indirect opportunity cost to the non-landowner an adverse impact.

An increase in switchgrass production would not be expected to result in an adverse impact to land enrolled in the CRP. The purpose of the CRP is to protect highly erodible land or other environmentally sensitive land with vegetative cover, not to protect or sustain the amount of land within the CRP. In the event it became economically advantageous to convert CRP land to switchgrass production, exchanging one system of perennial vegetation for another would be expected to involve minimal environmental changes, particularly with respect to soil and water quality impacts.

In summary, DOE anticipates that some land would be converted to switchgrass production, but the magnitude is unknown. Land use changes associated with increased switchgrass production would result in minimal to beneficial environmental impacts. The opportunity cost associated with increased switchgrass production would likely only impact the segment of livestock producers that rely on land not under their control for their livestock forage needs. DOE does not consider the indirect opportunity cost to a non-landowner an adverse impact.

Biomass from CRP Acreage

Grasslands enrolled in the CRP consist of perennial plants that are a potential feedstock for lignocellulosic ethanol. The *Food, Conservation, and Energy Act of 2008* (2008 Farm Bill) permits authority to allow managed harvesting of biomass from selected CRP acres. Such managed harvesting would be consistent with the conservation of soil, water quality, and wildlife habitat, and the associated rental payment would be reduced by an amount commensurate with the economic value of the authorized activity.

DOE used the *2007 Census of Agriculture* and *Conservation Reserve Program, Summary and Enrollment Statistics FY 2007* (FSA 2008) to estimate CRP acreage available for biomass harvesting within the region of influence. The acreage was then adjusted to account for the 2008 Farm Bill, which limited the number of CRP acres to 32 million acres (129,500 square kilometers) nationwide for 2010 to 2012. In fiscal year 2007, 36.8 million acres (149,000 square kilometers) were enrolled in the CRP (FSA 2008). For this analysis, DOE assumes this 13-percent reduction in CRP acreage nationwide would impact the region of influence similarly. Based on the information reviewed, DOE estimates 1.3 million dry tons (1.2 million dry metric tons) of harvestable CRP biomass within the region of influence. Comparatively, the anticipated demand for switchgrass/CRP biomass is 35,000 dry tons (31,750 metric tons) (Table 4-1). Using these data, the total annual biorefinery feedstock demand [875,000 dry short tons (793,800 dry metric tons)] would be approximately 70 percent of available CRP biomass within the region of influence, and the anticipated annual switchgrass/CRP demand [35,000 dry short tons (31,750 dry metric tons)] would be only 3 percent of available CRP biomass within the region of influence.

Since crop residue demand is not anticipated to change land use type (as described in the preceding crop residue analysis), there is no apparent incentive or mechanism to convert CRP land to cropland for the purpose of meeting crop residue feedstock demand. As described in the preceding switchgrass analysis, CRP land could be converted to switchgrass production, but the magnitude is unknown and would be expected to involve minimal environmental changes. Demand for CRP biomass would provide an additional incentive to keep land enrolled in the Program. Therefore, DOE anticipates that biorefinery demand for biomass would not significantly impact land enrolled in the CRP.

4.1.1.1.2 *Biomass Removal*

Physically removing biomass from the land for bioenergy production affects how the biomass would have otherwise been utilized (opportunity cost). Relative to land use, the Department is not necessarily concerned with the economic opportunity cost, but rather with the functional value of biomass lost by its removal. Similar to Section 4.1.1.1.1, crop residues are analyzed concurrently, but are separate from switchgrass and CRP.

Crop Residue

As described in Chapter 3, Section 3.1.1.2.2, crop residue has value as soil amendments and conservation functions. The impact of residue removal to these functions is discussed under the Soil Conditions heading below. Impacts relative to how the land is managed are discussed under Cropping Practices. The Livestock Feed section discusses instances where crop residue is currently utilized as forage.

Soil Conditions

As stated in Chapter 3, Section 3.1.1.1, the major soil resource concerns are wind erosion, water erosion, maintenance of the organic matter content and productivity of soils, and soil moisture management.

Sustainable biomass removal rates are sensitive to assumptions about the amount of crop residue that must remain in the field to maintain soil quality and organic matter, as well as limit erosion from water and wind. Generally, the amount of residue that needs to remain is a function of many variables, including tillage, crop rotations, and many location-specific variables such as soil type and field slope.

To maintain sustainable farming practices within the region of influence, Abengoa Bioenergy worked with local USDA Natural Resources Conservation Service (NRCS) representatives to evaluate residue removal rates with respect to limiting soil erosion (Roach 2009b). NRCS performed wind erosion calculations for all the agricultural practices and crop rotations typically found in the area (Roach 2009b). In the NRCS analysis, the maximum allowable removal rate for wheat and grain sorghum was 50 percent. The allowable removal rate for corn residue ranged between 50 and 75 percent. Abengoa Bioenergy's draft biomass purchase contract states that the product will be harvested in accordance with NRCS guidelines to properly address and minimize soil erosion. Therefore, the Proposed Action includes best management practices to determine field-specific removal rates that address and minimize soil erosion potential. Based on implementation of these management practices, DOE does not consider residue removal to be an adverse impact on soil relative to soil erosion.

Maintenance of *soil organic matter* content is identified as a major soil resource concern within the region of influence. Removal rates selected for wind erosion may not fully address this concern because the amount of residue needed to maintain soil organic carbon to avoid decreased crop productivity is generally greater than the residue requirements to avoid soil erosion (BRDB 2008). The quantity of residue that can be removed without reducing soil fertility will vary by field and regions and is the subject of ongoing research (BRDB 2008).

Based on this information, DOE concludes that crop residue removal could have an adverse impact on soil organic matter content in certain fields within the region of influence. However, the magnitude of this potential adverse impact cannot be quantified; therefore, DOE evaluated the magnitude qualitatively based on the following considerations:

- When managed properly, crop residue removal can have a beneficial impact on crop production;
- In some instances, crop residue removal rates based on soil erosion potential may be sufficient to maintain soil organic matter content;
- Crop residue removal rates based on soil erosion potential would leave approximately 25 to 50 percent of the crop residue in the field;
- Soil organic matter content depletion is gradual and reversible;
- Soil organic matter content can be monitored and managed;
- In order to reduce procurement costs, highly productive no-till fields are expected to be targeted. Leaving the root structure of plants undisturbed is vital to increasing soil carbon; in most cases, more so than leaving crop residues on the surface (USDA and DOE 2005);
- Comparing the Proposed Action to no-crop residue removal would not be accurate if current management practices remove some of the crop residue;

- The amount of land impacted by crop residue removal may significantly decrease over time as switchgrass becomes the primary feedstock;
- Considering the relatively low value of crop residue compared with the value of grain, if producers experienced a decrease in productivity connected to crop residue removal, they would be expected to take action to address the issue; and
- Producers that willingly enter the biomass purchase contract would have deemed that the potential benefits of crop residue removal outweigh the risks.

On a regional basis, the Department concludes that crop residue removal based on soil erosion rates would have a negligible impact on soil organic matter content. On a field-by-field basis, the Department concludes that crop residue removal would have a beneficial to minor adverse impact on soil organic matter content. Any adverse impact to soil organic matter content would be limited to the individual producer's land that would be compensated for residue removal.

As a soil amendment, the previous discussion on soil organic matter content generally incorporates related soil functions, properties, and environmental services. Abengoa Bioenergy's draft biomass purchase contract includes an optional Nutrient Replacement Program. DOE does not consider the removal of nutrients through biomass harvesting and the subsequent replacement of those nutrients into the soil an adverse impact. This is common agricultural practice.

DOE considers the loss or reduction in other crop residue conservation functions (soil moisture conservation for example) part of residue management for which the producer would be compensated and not an adverse impact. Producers are knowledgeable of crop residue management and enter into the biomass purchase contract with an understanding of potential implications.

Cropping Practices

The basic process that would be employed for harvesting biomass is presented in Section 2.1.2.1.1. The biomass harvesting system would use typical harvesting methods and equipment, occur independent of grain harvesting, and not impact traditional crop harvesting methods (Roach 2009c). In other words, producers would not be required to alter the cut height, windrow the residue, or otherwise alter their normal grain harvesting practices.

DOE does not anticipate impacts to existing conservation practices, such as conservation tillage, *cover crops*, windbreaks, vegetative wind barriers, stripcropping, terraces, or *contour farming*, because there is no apparent incentive to abandon these practices. Rather, the Proposed Action could encourage expanded use of these practices to maximize the amount of residue that could be removed and sold. The biomass purchase contract would not obligate producers to plant a particular crop in any particular year so crop rotations are not anticipated to be significantly altered.

Livestock Feed

As livestock feed, the opportunity cost is analogous to the previously described increase in switchgrass production and would likely only impact the segment of livestock producers that rely on land not under their control for their livestock forage needs. No associated concerns were raised by the livestock industry during the public scoping period (Chapter 1, Section 1.4.3). Furthermore, crop residues are a byproduct of grain production and not produced for the sole purpose of feeding livestock.

Switchgrass/CRP

Harvesting switchgrass/CRP biomass is anticipated to have a negligible impact on soil conditions. Perennial vegetation has a substantial root mass, which facilitates soil health and is protective of soil erosion. Because switchgrass is not currently produced and CRP biomass is not harvested, analysis of associated cropping practices is not applicable. Opportunity costs associated with changes in land use to produce switchgrass are discussed in the Section 4.1.1.1.1. From the perspective of this portion of the analysis, the opportunity cost of harvesting switchgrass intended for use as a *biofuel* is zero. The opportunity cost associated with CRP biomass removal is primarily related to wildlife habitat. Managed harvesting of biomass from selected CRP acres would have to be consistent with the conservation of soil, water quality, and wildlife habitat, including habitat during nesting seasons for birds in the area.

4.1.1.1.3 *Offsite Storage*

Seven *offsite storage locations* of approximately 160 acres (0.65 square kilometers) each would be located within 30 miles (48 kilometers) of the Biorefinery Project site. This equates to 1,120 acres (4.5 square kilometers) of offsite storage land. Abengoa Bioenergy is targeting non-irrigated, marginal land near major roads for these offsite storage locations, which would minimize impacts to productive agricultural land. No permanent structures are planned at the offsite storage locations so the land could be returned to its current use. Within the 50-mile (80-kilometer) region of influence, the offsite storage land represents 0.02 percent of all land. DOE does not consider this negligible and reversible reduction in land use to be an adverse impact.

4.1.1.1.4 *Conservation Programs*

Individual landowners have ultimate control of their land. However, the USDA provides many incentives to practice sustainable farming methods and participate in conservation programs. The CRP has been previously discussed in detail. The analysis of other conservation programs that retire or take land *out of production* (such as the Conservation Reserve Enhancement Program) is analogous to the previous CRP analysis. There is no apparent incentive or mechanism to convert out-of-production land to cropland to meet biomass demand. In the event it became economically advantageous to convert land enrolled in conservation programs to switchgrass production, exchanging one system of perennial vegetation for another would be expected to involve minimal environmental changes. Harvesting biomass from land enrolled in conservation programs would have to be done in accordance with Program rules and would be expected to have a negligible impact on soil conditions. The additional revenue generated from the biomass would provide an additional incentive to keep land enrolled in the Program.

Similarly, conservation programs on working land (such as the Conservation Security Program) are not anticipated to be adversely impacted. The excess of biomass indicates there would be little incentive to remove existing conservation practices in order to produce more biomass. Rather, the Proposed Action could encourage expanded use of conservation programs and practices on working lands in order to increase the amount of biomass that could be sustainably removed.

4.1.1.1.5 *Prime Farmland and Highly Erodible Land*

Chapter 3, Section 3.3 describes prime farmland and highly erodible land within the region of influence. DOE anticipates that prime farmland would not be adversely impacted by feedstock procurement. Rather, demand for crop residue encourages use of prime farmland for the production of crops. Prime farmland would not be targeted for feedstock storage.

DOE anticipates that highly erodible land would not be adversely impacted because biomass removal rates would be determined in accordance with NRCS guidelines for wind erosion. Also, the excess of available biomass would allow Abengoa Bioenergy to be selective in terms of feedstock procurement. Abengoa is expected to target highly productive land with limited soil resource concerns to maximize biomass removal.

4.1.1.1.6 *Public Lands*

DOE anticipates that public lands would not be adversely impacted by feedstock procurement because public lands would not be targeted for feedstock production.

4.1.1.2 Impacts Within 1 Mile (1.6 kilometers) of the Biorefinery Project Site

This section discusses impacts to land uses within the 1-mile region of influence. Some impacts to land uses would be temporary and limited to the biorefinery construction phase, while others would be longer lasting throughout biorefinery operations. Infrastructure construction-related impacts are anticipated to be confined to existing transportation and utility corridors and therefore relatively small. Impacts to land use as a result of increased development are also anticipated to be relatively small (Section 4.9).

The process water supply for the biorefinery would come from irrigated cropland from which Abengoa Bioenergy has conditionally obtained water rights. As with other infrastructure improvements, impacts associated with water supply line construction are anticipated to be minor, but the biorefinery demand for process water would impact use of the land from which the water rights were obtained. Figure 4-1 shows prime farmland in relation to water rights land, highlighting prime farmland that is currently irrigated on water rights land. Including the *buffer area*, water rights converted from cropland to the biorefinery represents approximately 4,300 acres (17.4 square kilometers). By comparison, the region of influence is estimated to contain over 1 million acres (4,000 square kilometers) of irrigated land. DOE considers this negligible reduction in irrigated cropland within the region of influence a small adverse impact. Some of the land associated with the water rights is considered by the USDA to be *prime farmland if irrigated*. Approximately 650 acres (2.6 square kilometers) of prime farmland if irrigated land would no longer be irrigated. All prime farmland in Stevens County is qualified "if irrigated" (NRCS 2006). The amount of prime farmland if irrigated soils that would no longer be irrigated represents 0.5 percent of prime farmland in the County. DOE considers this negligible and reversible reduction in prime farmland if irrigated a small adverse impact. All water rights land would remain available for non-irrigated crop production.

4.1.1.3 Impacts on the Biorefinery Project Site

The Proposed Action includes the direct conversion of land due to the construction of the biorefinery. Chapter 3, Section 3.1.3 describes conditions on the site of the biorefinery relative to this proposed land use change.

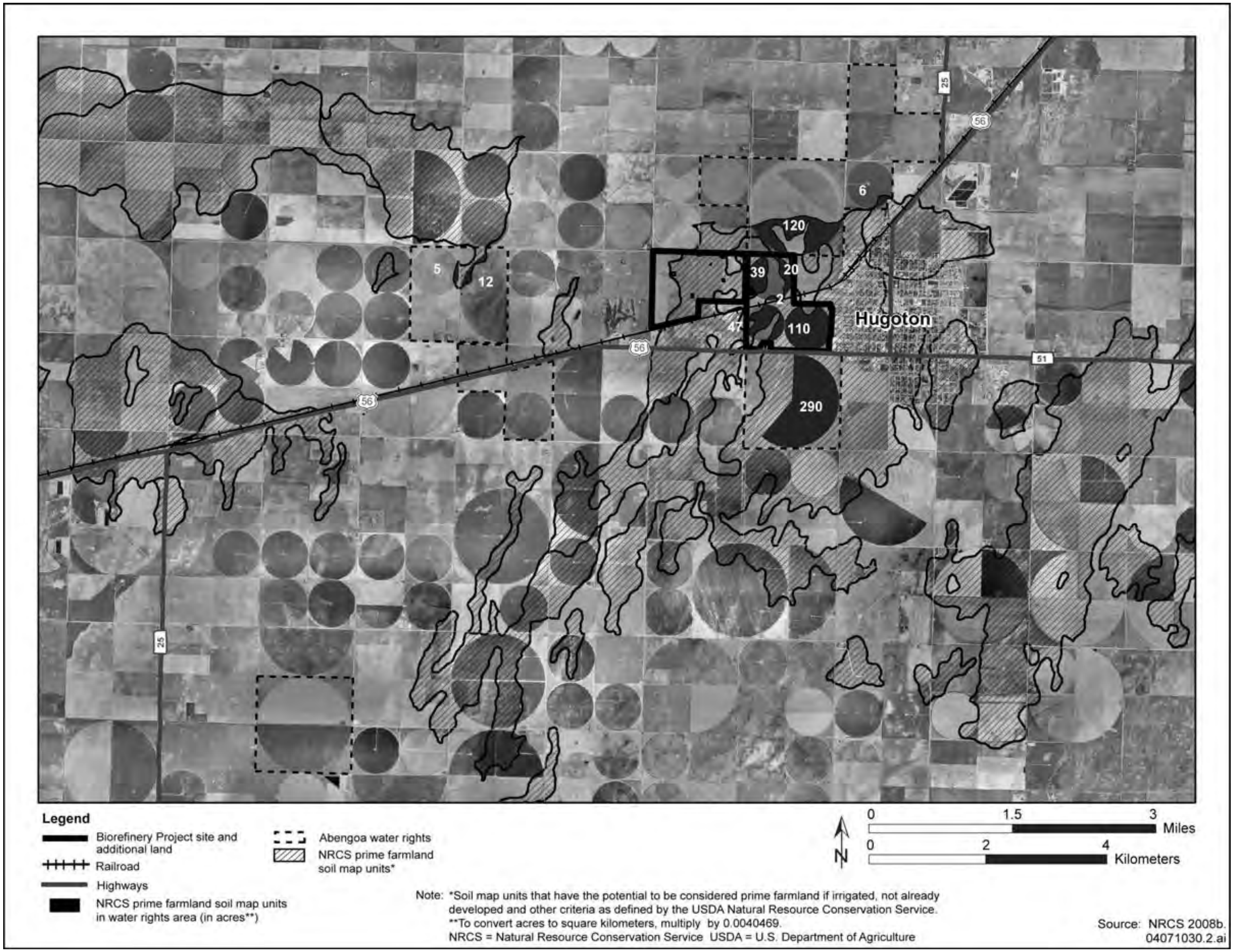


Figure 4-1. Prime farmland and water rights.

4.1.1.3.1 *Zoning*

Development of the biorefinery is consistent with land use in the neighboring industrial park and the conditional zoning change to I-2 Heavy Industrial. However, the rezoning and subsequent construction of the biorefinery would result in irreversible conversion of 385 acres (1.6 square kilometers) to non-agricultural use.

Abengoa Bioenergy does not plan to develop the buffer area. This land would instead be used for acquisition of water rights, production of energy crops, and irrigation with non-contact cooling water and wastewater treatment facility sludge (Roach 2009d). This land would not be rezoned from A-L Agricultural District, and Abengoa's use of the land would not constitute irreversible conversion of farmland.

4.1.1.3.2 *Site Assessment*

Approximately 66 percent of the soils on the Biorefinery Project site are classified as prime farmland if irrigated. DOE used the USDA NRCS land evaluation and site assessment system to establish a farmland conversion impact rating score on the Project site. The site assessment criteria are designed to assess important factors other than the agricultural value of the land when determining if land should receive a high level of protection from conversion to non-agricultural uses. A local USDA NRCS resource conservationist assigned a relative value of 69 out of 100 for the Project site (Graber 2008). DOE completed the site assessment criteria and assigned a value of 57 out of 160. The combined score is 126 out of 260. Sites with a total score of less than 160 are not given further consideration for protection under the *Farmland Protection Policy Act*. The Project site's proximity to the West Industrial Park and the city of Hugoton contributed to a relatively low score. Other factors that contribute to a relatively low score include the size of the site in comparison with the average farm size and total farmland in the county. The Project site is 66 percent of the average farm size and represents 0.17 percent of the total farmland in Steven's County. This reduction in farmland is anticipated to have little, if any, impact on land use and farm support services.

4.1.2 ACTION ALTERNATIVE

Similar to the Proposed Action, the Action Alternative environmental impacts analysis is organized into the three geographical areas: impacts within 50 miles (80 kilometers) of the Biorefinery Project site (Section 4.1.2.1), impacts within 1 mile (1.6 kilometers) of the Project site (Section 4.1.2.2), and impacts on the Project site (Section 4.1.2.3).

4.1.2.1 Impacts within 50 Miles (80 kilometers) of the Biorefinery Project Site

This section evaluates land use impacts under the Action Alternative related to biomass demand (Section 4.1.2.1.1), biomass removal (Section 4.1.2.1.2), offsite storage of biomass (Section 4.1.2.1.3), conservation programs (Section 4.1.2.1.4), and prime farmland, highly erodible land, and public lands (Section 4.1.2.1.5).

4.1.2.1.1 *Biomass Demand*

For the Action Alternative, the biorefinery would use approximately 770 dry short tons (700 dry metric tons) per day of lignocellulosic feedstock. Operating 350 days per year, this equates to 270,000 dry short tons (245,000 dry metric tons) per year. With the exception of the biomass feedstock demand quantity, the biomass procurement system under the Action Alternative is identical to that for the Proposed Action. The biomass demand under the Action Alternative is approximately 30 percent of that demanded for the Proposed Action. The amount of biomass available for harvesting and the type and proportion of biomass targeted are identical for the Action Alternative and the Proposed Action. Therefore, DOE's conclusions regarding biomass demand under the Action Alternative are qualitatively the same as for the Proposed Action, but quantitatively reduced proportionally:

4.1.2.1.2 *Biomass Removal*

With the exception of the biomass feedstock demand quantity, the biomass procurement system under the Action Alternative is identical to that for the Proposed Action. DOE anticipates biomass removal under the Action Alternative would impact approximately 30 percent of the acreage that would be impacted under the Proposed Action. Therefore, DOE's conclusions regarding crop residue removal under the Action Alternative are qualitatively the same for the land impacted, but the quantity of land impacted would be reduced proportionally.

4.1.2.1.3 *Offsite Storage*

Under the Action Alternative, Abengoa Bioenergy is expected to target similar types of land for offsite storage as for the Proposed Action; namely, non-irrigated, marginal land near major roads to minimize impacts to productive agricultural land. Further, the offsite storage locations would be located within 30 miles (48 kilometers) of the Biorefinery Project site, and DOE assumes no permanent structures are planned at the offsite storage locations. DOE expects that offsite storage acreage under the Action Alternative would be approximately 30 percent of the acreage needed under the Proposed Action. DOE does not consider this negligible and reversible reduction in land use to be an adverse impact.

4.1.2.1.4 *Conservation Programs*

With the exception of the biomass feedstock demand quantity, the biomass procurement system under the Action Alternative is identical to that for the Proposed Action Since the Proposed Action impacts to conservation programs are nonexistent or relatively minor, impacts to conservation programs under the Action Alternative are likewise nonexistent or relatively minor.

4.1.2.1.5 *Prime Farmland, Highly Erodible Land, and Public Lands*

As with the Proposed Action, DOE anticipates that prime farmland, highly erodible land, and public lands would not be adversely impacted by feedstock procurement under the Action Alternative.

4.1.2.2 Impacts within 1 Mile (1.6 kilometers) of the Biorefinery Site

Under the Action Alternative, infrastructure- and development-related impacts would be relatively unchanged compared with those for the Proposed Action. Relative to land use, there is no significant difference between the Action Alternative and the Proposed Action.

4.1.2.3 Impacts on the Biorefinery Project Site

Relative to land use, there is no significant difference between the Action Alternative and the Proposed Action. In either case, the Biorefinery Project site would be converted from agricultural land and the zoning changed from agricultural to heavy industrial. Under the Action Alternative, DOE is not aware of any parameters that would significantly change land use on the Project site relative to those discussed for the Proposed Action.

4.1.3 SUMMARY OF LAND USE IMPACTS

4.1.3.1 Proposed Action Impact Summary

Production of crop residue in the region of influence exceeds the anticipated biorefinery demand for biomass. Thus, there would be little or no incentive to alter land use to meet this demand. DOE concludes that demand for crop residue by the biorefinery would have a negligible impact on changes in land use type, including the CRP. Biorefinery demand or utilization of CRP biomass would provide an incentive to keep land enrolled in the CRP. Therefore, the Department concludes that demand for biomass by the biorefinery would have a negligible impact on land enrolled in CRP. The total conversion of land to switchgrass production cannot be determined with any certainty, but the environmental impact is expected to be minimal to beneficial. DOE does not consider the indirect opportunity cost of increased switchgrass production to a non-landowner an adverse impact and expects increased switchgrass production would result in minor, if any, environmental impacts to CRP acreage.

DOE does not consider biomass removal in accordance with NRCS guidelines or USDA program rules to be an adverse impact relative to soil erosion. On a regional basis, the Department concludes that crop residue removal under the Proposed Action would have a negligible impact on soil organic matter content. On a field-by-field basis, the Department concludes that crop residue removal would have a beneficial to minor adverse impact on soil organic matter content. Any adverse impact to soil organic matter content would be limited to the individual producer's land that would be compensated for residue removal. DOE does not anticipate adverse impacts relative to cropping practices or in addition to the crop residue opportunity costs previously discussed. DOE anticipates harvesting switchgrass and CRP biomass would have a negligible impact on soils conditions, and any associated opportunity costs would be negligible.

DOE considers the negligible and reversible reduction in land use converted to offsite storage a negligible adverse impact. DOE also does not anticipate significant adverse impacts to conservation programs, prime farmland, highly erodible land, or public lands. DOE anticipates small infrastructure and offsite development land use impacts associated with the Proposed Action. DOE considers the negligible and reversible reduction in irrigated land from water rights conversion a negligible adverse impact. Further, DOE considers the conversion of farmland on the Biorefinery Project site to be a negligible adverse impact.

4.1.3.2 Action Alternative Impact Summary

Under the Action Alternative, land impacted by the feedstock procurement would be approximately 30 percent of that impacted under the Proposed Action. Though the quantity of impact would be less, the nature of the impact would be the same. No significant adverse impacts were identified for the Proposed Action; likewise, no significant adverse impacts are anticipated under the Action Alternative. Feedstock demand-induced changes in land use (either adverse or beneficial) would be reduced proportionally. Total feedstock removal impacts would also be reduced proportionally, but field-level impacts would remain unchanged. The Action Alternative would not change removal rates from specific fields, just the total amount of land needed for feedstock. The amount of land needed for offsite storage would also be reduced proportionally.

4.2 Air Quality

This section describes the potential *air quality* impacts associated with the Proposed Action and Action Alternative. Section 4.2.1 describes the impacts of the Proposed Action and Section 4.2.2 describes the impacts of the Action Alternative.

Evaluating air quality impacts requires knowledge of the emission sources, pollutant types, *source emission rates*, *release parameters*, the proximity relationship of project emission sources to other emission sources, and local and regional meteorological conditions. To evaluate air quality impacts, DOE performed *dispersion modeling* for four *criteria pollutants* and compared the results with national standards. This section presents an overview of greenhouse gas and climate change as well as the sources of greenhouse gas from the biorefinery.

4.2.1 PROPOSED ACTION

4.2.1.1 Impacts During the Construction Phase

Construction of the biorefinery would cause *fugitive dust* and other emissions from various activities associated with heavy diesel-operated equipment, disturbance of the soil, grading activities, material transport, and material handling. These activities are generally short term or intermittent in nature and would only occur during the 18-month construction phase. Abengoa Bioenergy would conduct each of the dust-generating activities with best management practices, including watering to stabilize disturbed areas, limiting activities in areas not being used for construction, limiting the number of site access points, and staging construction activities to avoid simultaneous dust-generating activities. To control other emissions-generating activities, Abengoa would use well-maintained construction equipment with appropriate emissions controls to reduce the tailpipe emissions from diesel-operated heavy machinery.

4.2.1.2 Impacts During the Operations Phase

Operation of the biorefinery would be a source of air pollutants as well as greenhouse gas. Table 4-2 presents a summary of the emission sources by group and the expected emissions from each source group. Abengoa Bioenergy recently submitted an amended air quality construction permit application to the Kansas Department of Health and Environment, Bureau of Air and Radiation (ABHK 2009). The air quality construction permit application included a detailed quantification of the potential emissions and an analysis of *best available control technologies* to reduce emissions. If issued, the air permit would include conditions to demonstrate that the biorefinery would meet federal and state air quality regulations. In accordance with the New Source Review permitting program under the *Clean Air Act*, the biorefinery cannot receive an air quality permit to construct unless it is demonstrated that the impacts will be less than levels deemed to be protective of human health and the environment and that would not degrade the existing air quality (40 CFR 52.21). Table 4-3 shows the potential emission summaries for the Proposed Action both with and without proposed controls in place (Roach 2009f).

To determine impacts to the existing air quality resulting from the Proposed Action, DOE performed air dispersion modeling using the American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD) (EPA 2004). The modeled concentrations were added to the background values presented in Chapter 3, Section 3.2, and the resulting concentrations were compared with the *National Ambient Air Quality Standards*, also presented in Section 3.2. The dispersion modeling

Table 4-2. Emission sources under the Proposed Action.

Equipment/Process	Expected emissions
Onsite biomass handling and milling	PM, PM_{10}, and $PM_{2.5}$
Enzymatic hydrolysis pretreatment, fermentation, and distillation	PM, PM_{10}, and $PM_{2.5}$, VOCs, HAPs, GHGs
Lignin-rich stillage storage and loadout	VOCs and HAPs
Ethanol and denaturant loadout	PM, PM_{10}, and $PM_{2.5}$, VOCs, HAPs
Power generation	PM, PM_{10}, and $PM_{2.5}$, NO_x, SO_2, CO, VOCs, HAPs, GHGs
Ash storage and handling	PM, PM_{10}, and $PM_{2.5}$
Cooling towers and air condensers	PM, PM_{10}, and $PM_{2.5}$
Emergency equipment	PM, PM_{10}, and $PM_{2.5}$, NO_x, SO_2, CO, VOCs, HAPs, GHGs
Fugitive emissions	PM, PM_{10}, and $PM_{2.5}$, VOCs, HAPs

Source: ABHK 2009.
CO = carbon monoxide.
GHG = greenhouse gas (such as carbon dioxide and methane).
HAP = hazardous air pollutant (such as acetaldehyde and formaldehyde).
NO_x = nitrogen oxides.
PM_{10} = particulate matter with an aerodynamic diameter less than or equal to 10 micrometers.
$PM_{2.5}$ = particulate matter with an aerodynamic diameter less than or equal to 2.5 micrometers.
PM = particulate matter.
SO_2 = sulfur dioxide.
VOC = volatile organic compound (such as ethanol).

Table 4-3. Summary of emissions under the Proposed Action.

Pollutant	Uncontrolled facility-wide emissions		Controlled facility-wide emissions	
	Tons per year[a]	Metric tons per year	Tons per year[a]	Metric tons per year
Particulate matter	4,820.53	4,373.09	232.88	211.26
PM_{10}	3,923.22	3,559.07	215.13	195.16
$PM_{2.5}$	3,256.70	2,954.41	205.68	186.59
Nitrogen oxides	1,985.11	1,800.85	993.21	901.02
Sulfur dioxide	1,657.27	1,503.44	166.06	150.65
Carbon monoxide	1,065.54	966.64	1065.54	966.64
Volatile organic compounds	2,779.56	2,521.56	157.45	142.84
Single hazardous air pollutant	1,853.96	1,681.88	18.54	16.82
Total hazardous air pollutants	2,009.06	1,822.58	32.37	29.37

Source: Roach 2009f.
PM_{10} = particulate matter with an aerodynamic diameter less than or equal to 10 micrometers.
$PM_{2.5}$ = particulate matter with an aerodynamic diameter less than or equal to 2.5 micrometers.

completed by DOE was performed independent of the air permit, but used the same emission calculations that were developed for the air quality permit application based on the April 2009 biorefinery design (Salter 2009a). DOE analyzed four criteria pollutants using the air dispersion model: PM_{10}, nitrogen oxides (assuming 100-percent conversion to nitrogen dioxide), sulfur dioxide, and carbon monoxide. Each of the four pollutants was modeled for the averaging periods for which federal air quality standards exist using 5 years (2002 through 2006) of meteorology data that are representative of the climatology of the Hugoton area (Salter 2009b). The emission rates used in the model assume the proposed controls and best management practices are in place and operational. *Receptor points* were placed along the fence line of the 385-acre (1.6-square-kilometer) *biorefinery parcel* out to 8,200 feet (2,500 meters) from the fence line on all sides. Figure 4-2 shows the receptor points relative to the parcel.

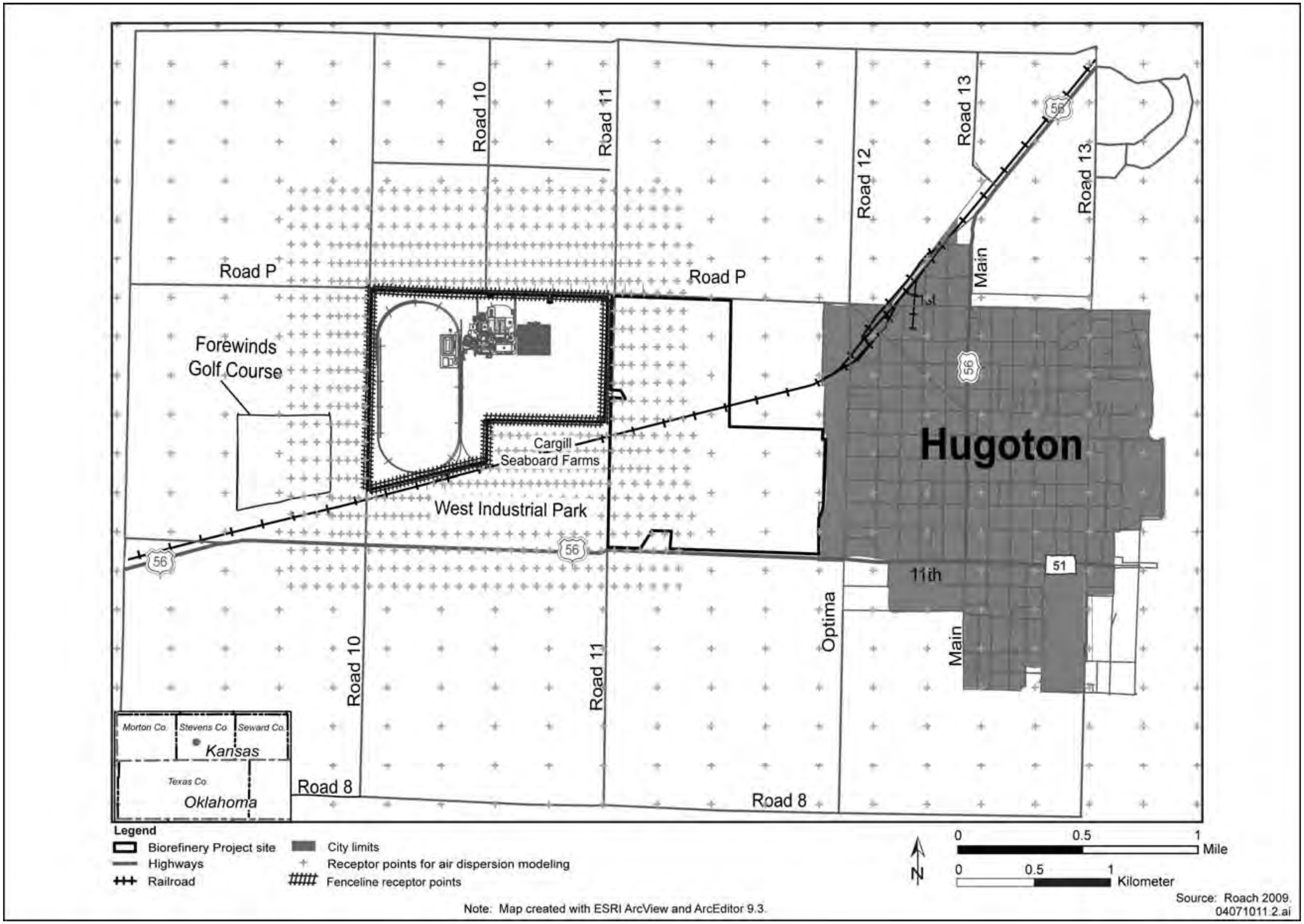


Figure 4-2. Locations of receptor points used in the model.

Table 4-4 shows a summary of the modeled impacts. For each pollutant and averaging time, the maximum modeled concentration is listed along with the background concentration. The impact is the sum of the maximum model increment and the background. All of the impacts are well below the National Ambient Air Quality Standards. For all pollutants and averaging times, the maximum modeled concentration occurs north of the biorefinery, approximately 100 meters (325 feet) north of the fence line. Although Hugoton is included in the model receptor grid, none of the maximum model concentrations occur at or near any of the receptors in Hugoton. Complete details of the parameters used in the air dispersion model are presented in Appendix F.

Table 4-4. Summary of model results for the Proposed Action.

Pollutant	Averaging period	Year of maximum modeled impact[a]	NAAQS[b] (μg/m^3)	Background[c] (μg/m^3)	Maximum model result (μg/m^3)	Total impact (μg/m^3)
Carbon monoxide	1-hour	2003	40,000	2,300	800	3,100
	8-hour	2003	10,000	570	120	690
Nitrogen dioxide	Annual	2002	100	8.0	9.6	18
Sulfur dioxide	3-hour	2003	1,300[e]	10	40	50
	24-hour	2004	370	8.0	10	18
	Annual	2002	78	3.0	1.3	4.3
PM_{10}	24-hour	2004	150	60	20	90
	Annual	2005	Revoked[d]	20	4.5	25

a. The modeling analysis was completed using five years of processed meteorological data from 2002 through 2006.
b. Source: 40 CFR Part 50.
c. Source: Lavery 2009.
d. The PM_{10} annual standard was 50 μg/m^3 prior to being revoked by EPA.
e. Secondary standard.
NAAQS = National Ambient Air Quality Standards.
PM_{10} = particulate matter with an aerodynamic diameter less than or equal to 10 micrometers.
μg/m^3 = micrograms per cubic meter.

The biorefinery design parameters and associated values necessary to estimate emissions and therefore concentrations of air pollutants under the Proposed Action will not be finalized until after publication of this draft Abengoa Biorefinery Project EIS. The description of the biorefinery and its operations discussed in Chapter 2, and the estimates of air pollutant emissions shown in Table 4-3, represent the latest available information (as of August 2009). The air pollutant concentrations shown in Table 4-4, however, reflect the design parameters and associated values of an earlier biorefinery design (April 2009).

In general, the August 2009 design would result in a relative increase in the amount of biomass processed in the biorefinery [2,500 versus 1,700 short dry tons (2,300 versus 1,500 dry metric tons) per day], which would result in a relative increase in the production of ethanol [18 versus 12 million gallons (68 versus 45 million liters) per year] and electricity (92 versus 60 megawatts) and associated byproducts and wastes. No *syngas* would be produced relative to the August 2009 design. DOE anticipates the final design parameters and associated values are likely to result in air pollutant concentrations greater than those shown in Table 4-4; however, they are not likely to increase substantially. Preliminary calculations show that when *particulate matter*, carbon monoxide, sulfur dioxide, and nitrogen oxide emissions are increased to reflect the most recent biorefinery design, the corresponding increase in pollutant concentrations do not approach, and therefore will not exceed, the National Ambient Air Quality Standards.

As mentioned, the modeled impacts have been calculated with proposed emission controls in place. The emission controls have been evaluated in accordance with best management practices and required best available control technology requirements. These controls include:

- Pave in-plant haul roads and post a maximum speed limit of 15 miles (24 kilometers) per hour to control particulate matter, PM_{10}, and $PM_{2.5}$. Additional maintenance, such as sweeping and watering the paved roads, also would provide control for particulate matter;

- Reduce particulate matter, PM10, and PM2.5 fugitive emissions from unpaved biomass laydown roads through the use of chemical stabilization and wind fences;

- Reduce particulate matter, PM_{10}, and $PM_{2.5}$ emissions in the onsite biomass handling and milling systems and from the ash handling systems by using dust collectors (baghouses);

- Increase capture efficiency of particulate matter, PM10, and PM2.5 emissions resulting from the biomass grinding process by maintaining negative pressure in the enclosed grinding systems;

- Install and operate high-efficiency wet scrubbers on biomass *fermentation* and *distillation* operations for volatile organic compound and hazardous air pollutant control;

- Install and operate condensers on biomass process vents for volatile organic compound control;

- Reduce nitrogen oxide emissions from the boilers by utilizing a selective non-catalytic reduction system;

- Equip ethanol and denaturant storage tanks with internal floating roof designs to control volatile organic compound and hazardous air pollutant emissions;

- Route emissions from ethanol loadout to a vapor recovery system for volatile organic compound and hazardous air pollutant control; and

- Control equipment leaks that would result in emissions of fugitive volatile organic compounds and hazardous air pollutants through the use of a leak detection and repair protocol.

4.2.1.3 Potential Impacts of Ethanol Production on Greenhouse Gas Emissions

Greenhouse gases exist in the earth's atmosphere and absorb outgoing infrared radiation, thus trapping heat in the atmosphere. Some greenhouse gases, such as water vapor, carbon dioxide, methane, and nitrous oxide, occur naturally and from *anthropogenic* activities (resulting from or produced by human beings). Other greenhouse gases, such as hydrofluorocarbons, result only from anthropogenic activities. In the United States, energy-related carbon dioxide emissions represent the majority of the total greenhouse gas emissions from anthropogenic sources. The Abengoa biorefinery would be a source of greenhouse gases, including carbon dioxide, methane, and nitrous oxide.

The Intergovernmental Panel on Climate Change was established by the United Nations Environment Programme and the World Meteorological Organization to provide a scientific perspective on climate change by reviewing and assessing worldwide scientific, technical, and socioeconomic data relevant to climate change. The reports written by the Panel are considered to be respected sources of information regarding global warming and climate change issues. The Panel published the four-volume Fourth Assessment Report, *Climate Change 2007* (IPCC 2007a). The information provided in Sections 4.2.1.3.1, 4.2.1.3.2, and 4.2.1.3.3 is drawn from the Fourth Assessment Report. Sections 4.2.1.3.4 and 4.2.2.1 provide greenhouse gas emission estimates under the Proposed Action and Action Alternative, respectively.

4.2.1.3.1 *Background*

Greenhouse gases, such as carbon dioxide, methane, and nitrous oxide, are chemically stable and persist in the atmosphere, thus becoming well mixed throughout the atmosphere before being removed by physical or chemical processes. Because these stable gases are well mixed, the impacts from their presence occur over a larger region than a local airshed. For this reason, greenhouse gas concentrations are typically discussed on a global or regional scale rather than local; likewise, the impacts of atmospheric concentrations of greenhouse gases are also discussed on a global or regional scale.

Based on data from polar ice core records, global concentrations of carbon dioxide, methane, and nitrous oxide have increased from pre-industrial era levels. The pre-industrial concentration of atmospheric carbon dioxide was approximately 280 parts per million (500 milligrams per cubic meter), and by 2005 had increased to 379 parts per million (680 milligrams per cubic meter). Further, the annual rate of increase in carbon dioxide concentrations, based on direct measurements that began in the 1950s, also has continued to increase, with the highest rate occurring in the past decade (Forster et al. 2007).

The Intergovernmental Panel on Climate Change attributes the increase in greenhouse gases largely to anthropogenic sources. Prior to the industrial era, concentrations of atmospheric carbon dioxide had increased by only 20 parts per million (36 milligrams per cubic meter) in approximately 8,000 years, with multi-decadal to centennial variations being less than 10 parts per million (18 milligrams per cubic meter) (Solomon et al. 2007). Thus, the contribution in atmospheric carbon dioxide due to natural sources has historically been much lower than the contribution due to anthropogenic sources.

Anthropogenic sources include, for example, fossil fuel use, changes in land uses, and agricultural activities. The Intergovernmental Panel on Climate Change has concluded that fossil fuel use is the predominant source of atmospheric carbon dioxide concentrations, although land use changes also contribute; methane concentrations have increased over time largely due to fossil fuel use and agriculture; and nitrous oxide concentrations have increased primarily due to agricultural activities (IPCC 2007b).

4.2.1.3.2 *Impacts of Greenhouse Gas*

The climate of a region is the generally prevailing or average weather conditions of that region, including temperature and precipitation, statistically described over periods ranging from a few months to hundreds or thousands of years. The climate system is a complex system, influenced by interactions between the atmosphere, oceans, land surface, and human activities. Climate changes can be attributed to natural influences, such as an erupting volcano, or from human activities. Many factors influence climate. The Intergovernmental Panel on Climate Change, however, states that it is "very likely" (greater than 90-percent probability) that greenhouse gases have been the cause of the observed global warming over the past 50 years, and that it is "very unlikely" (less than 10-percent probability) that global warming over the past 50 years can be explained through known natural external causes alone (Solomon et al. 2007). Further, with greater than 66-percent probability, the warming caused by anthropogenic greenhouse gas emissions has influenced changes in physical and biological systems on global and regional scales (IPCC 2007b).

Global observations of climate change due to warming include increases in average air and ocean temperatures, rising average ocean levels, and decreases in the amount of snow and ice. Further, extreme temperature events have changed globally; the number of cold days has decreased and the number of heat waves has increased (IPCC 2007b). Regional impacts include increased precipitation in eastern portions of North and South America and northern Europe, but decreased precipitation in areas such as southern Asia, Africa, and the Mediterranean. Other regional changes include increasing intense tropical cyclone activity in the North Atlantic as well as biological changes such as bird migratory patterns and changes in the Arctic region food chain (IPCC 2007b). There is also a 5 in 10 chance that other regional impacts due to climate change are occurring. These impacts include changes on human environments such as earlier spring planting in the Northern Hemisphere and changes in regional human disease vectors (IPCC 2007b).

The Intergovernmental Panel on Climate Change anticipates that climate change will continue, and the Panel has developed future projections based on emission scenarios and results from climate models (IPCC 2007b). Results of these projections vary based on the scenario or model used, however, the general conclusion is that emissions of greenhouse gases at or above current rates would cause further climate change impacts, such as:

- A continuing rise in global average ocean temperatures and levels,
- Loss of plant and animal species,
- Increased morbidity from heat waves, and
- Increased coastal damage from floods and storms.

In North America, warming in the western mountains could alter the snowpack and associated water runoff, thus increasing the competition for water resources. Some of the impacts may be irreversible, such as species extinction (IPCC 2007b).

4.2.1.3.3 *Addressing Greenhouse Gas and Climate Change*

Climate change and the impacts caused by climate change are global issues and thus must be addressed on a global scale. Reducing the global levels of greenhouse gas (mitigation) and adapting to the impacts are two methods to respond to climate change. While mitigation and adaptation can be complimentary or independent of each other, both are necessary to address climate change impacts. The effects of mitigation strategies are more global, but the effects may not be noticed for decades due to lag times in climate, biophysical, and socioeconomic systems. The effects of adaptation are typically more local or regional and can have almost immediate effects depending on the type of adaptation. Adaptation will be necessary to address impacts that are already occurring due to past emissions. Mitigation will be necessary so that some climate change may be avoided or reduced in the future (IPCC 2007b).

Methods for reducing future greenhouse gas levels are being undertaken through the development and use of various technologies and the identification and implementation of energy policies. In the energy sector, technologies are available that would allow energy production to switch from coal to gas and/or renewable heat and power sources. In the transportation sector, policies, such as mandatory vehicle fuel economy, can also help to reduce greenhouse gas emissions. As explained further below, the use of biofuel and biopower, such as the Abengoa biorefinery would produce, would also be technologies to help reduce the levels of greenhouse gas. The Intergovernmental Panel on Climate Change states that studies indicate much evidence of economic potential for reducing greenhouse gas levels in the coming decades such that global emission levels could be offset or even reduced below current levels (IPCC 2007b).

4.2.1.3.4 *Greenhouse Gas from the Proposed Action*

The Abengoa biorefinery would be a source of greenhouse gases, with carbon dioxide being the most abundant. The boilers would be the main source of carbon dioxide, methane, and nitrous oxide. Carbon dioxide also would be emitted by the biomass fermentation and distillation processes. A summary of the controlled Abengoa biorefinery greenhouse gas emissions by emission source is shown in Table 4-5.

Table 4-5. Summary of Abengoa biorefinery greenhouse gas emissions for the Proposed Action.

	Controlled facility-wide greenhouse gas emissions					
	Carbon dioxide		Methane		Nitrous oxide	
Emission Source	Tons per year[a]	Metric tons per year	Tons per year[a]	Metric tons per year	Tons per year[a]	Metric tons per year
Fermentation and distillation process vent	56,616	51,361	0	0	0	0
Biogas flare	717	650	0.001	0.0009	0.0001	0.00009
Boiler #1	782,699	710,053	255	231	33.4	30.3
Boiler #2	782,699	710,053	255	231	33.4	30.3
Firewater pump engine	190	172	0.008	0.007	0.002	0.002
Emergency power generator	616	559	0.03	0.03	0.005	0.005
Total	1,623,537	1,472,848	510	462	66.8	60.6

a. Source: Roach 2009f.

Different greenhouse gases have different radiative forcing properties and, consequently, different global warming potentials. As such, merely adding the tons of emissions for carbon dioxide, methane, and nitrous oxide for each source in Table 4-5 is not helpful in understanding the total global warming potential of emissions from operation of the Abengoa biorefinery. A uniform value is needed. To evaluate non-carbon dioxide greenhouse gas emissions from the Proposed Action, the mass estimates of the non-carbon dioxide greenhouse gas emissions were converted into a carbon dioxide equivalent value. Table 4-6 presents the non-carbon dioxide greenhouse gas emissions in terms of carbon dioxide equivalents using two sets of global warming potentials: one drawn from the Technical Summary of the Intergovernmental Panel on Climate Change's Fourth Assessment Report (Solomon et al. 2007) and one drawn from the Panel's Second Assessment Report (IPCC 1995). Both sets of carbon dioxide equivalents are provided in the table because the global warming potentials from the Second Assessment Report were used for reporting under the United Nations Framework Convention on Climate Change, and the global warming potentials from the Fourth Assessment Report are updated values. The total greenhouse gas emissions in carbon dioxide equivalents from the Proposed Action, which is shown in the last row of Table 4-6, is the sum of the total carbon dioxide from Table 4-5, the total methane in carbon dioxide equivalents from Table 4-6, and the total nitrous oxide in carbon dioxide equivalents from Table 4-6.

Table 4-6. Summary of biorefinery carbon dioxide equivalents for the Proposed Action.

Emission Source	Fourth Assessment Report values[a]				Second Assessment Report values[b]			
	Methane		Nitrous oxide		Methane		Methane	
	Tons per year	Metric tons per year	Tons per year	Metric tons per year	Tons per year[c]	Metric tons per year	Tons per year[c]	Metric tons per year
Fermentation and distillation process vent	0	0	0	0	0	0	0	0
Biogas flare	0.02	0.02	0.03	0.03	0.02	0.02	0.03	0.03
Boiler #1	6,363	5,772	9,954	9,030	5,345	4,849	10,355	9,394
Boiler #2	6,363	5,772	9,954	9,030	5,345	4,849	10,355	9,394
Firewater pump engine	0.19	0.17	0.46	0.42	0.16	0.15	0.48	0.44
Emergency power generator	0.63	0.57	1.51	1.37	0.53	0.48	1.57	1.42
Total of non-carbon dioxide equivalents	12,727	11,545	19,910	18,062	10,691	9,699	20,712	18,790
	Tons per year		Metric tons per year		Tons per year		Metric tons per year	
Total carbon dioxide equivalents[d]	1,656,174		1,502,455		1,654,940		1,501,337	

a. The global warming potentials for methane and nitrous oxide are 25 and 298, respectively (Solomon et al. 2007).
b. The global warming potentials for methane and nitrous oxide are 21 and 310, respectively (IPCC 1995).
c. Source: Roach 2009f.
d. Total carbon dioxide equivalents are the sum of the total non-carbon dioxide equivalents (methane and nitrous oxide) and the total carbon dioxide from Table 4-5.

Based on emissions estimates for the Abengoa biorefinery (Proposed Action) and using the global warming potentials from the Intergovernmental Panel on Climate Change Second Assessment Report, the total emissions of carbon dioxide equivalents from the Abengoa biorefinery would be 1.65 million tons (about 1.497 million metric tons) per year (Roach 2009f). The total emissions of carbon dioxide equivalents from the Abengoa biorefinery using the global warming potentials from the Panel's Fourth Assessment Report would be 1.66 million tons (about 1.51 million metric tons) per year. According to the Energy Information Administration, the total U.S. greenhouse gas emissions in 2007 were 8,027 million tons (7,282 million metric tons) of carbon dioxide equivalent, with 6,604 million tons (5,991 million metric tons) of the total from energy-related carbon dioxide (DOE 2008). The projected greenhouse gas emissions from the Abengoa biorefinery would be 0.021 percent of the total U.S. carbon dioxide equivalent value.

Greenhouse gases emitted by the Abengoa biorefinery would mix and be stable in the atmosphere and would not result in any direct impacts to the Hugoton area. The emissions would pose no direct hazard to human health, such as from toxicity or asphyxiation, and any incremental climate change impacts attributable to the relatively small quantities of greenhouse gases the Proposed Action would emit would be too small to observe, either globally or in the Hugoton area. However, the greenhouse gases the Abengoa biorefinery would emit would add to past and future emissions from all other sources of U.S. and global greenhouse gas emissions, contributing to cumulative impacts on climate change, such as those described in Section 4.2.1.3.2. At present, there is no methodology that would allow DOE to correlate greenhouse gas emissions from the Proposed Action to any specific climate change impact.

Although the Abengoa biorefinery would be a source of greenhouse gas emissions, operation of the Abengoa biorefinery would provide a net reduction in greenhouse gas emissions. To determine the level of greenhouse gas reduction from the Proposed Action, DOE used the Greenhouse gases, Regulated Emissions, and Energy use in Transportation (GREET) Model (Wang et al. 2007a). The *GREET Model* examines "well-to-wheel" fuel lifecycles by taking into consideration factors such as producing raw materials for fuels, refining the raw materials into fuels, and using the fuel in vehicles.

The baseline in the GREET Model considers passenger vehicles that use 100-percent conventional gasoline and/or reformulated gasoline. The well-to-wheels lifecycle for this baseline includes greenhouse gas emissions from the oil field in which crude oil is pumped, transportation of the crude oil to refineries, the refining process to produce gasoline, transportation of the gasoline to stations, and then use of the gasoline in passenger vehicles.

To estimate the relative reduction in greenhouse gas emissions under the Proposed Action, the GREET Model includes factors (parameters) that reflect operation of the biorefinery. The well-to-wheels lifecycle for the Proposed Action therefore includes harvesting and transporting biomass to the biorefinery, processing the biomass feedstock into ethanol and electricity, transporting the ethanol fuel to stations, and using the fuel in vehicles. More specifically, the GREET Model analysis includes a greenhouse gas emissions "credit" to account for the biorefinery's production of electricity that would be exported to the regional grid. Although the GREET Model can account for land use changes due to biomass demand following biomass removal, as described in Section 4.1.1.1.2, DOE does not anticipate this demand for biomass (corn stover) would result in land use changes (that is, greenhouse gas emissions for land use were not changed from the default value of zero). The GREET Model also accounts for emissions associated with nutrient replacement following biomass removal.

The GREET Model analysis includes corn stover as the source of biomass feedstock. As described in Chapter 2, Section 2.1.2.1.1, over time, Abengoa Bioenergy would increase the use of switchgrass until it became the primary feedstock. DOE determined (Section 4.1.1.1.1) that switchgrass production would likely occur on marginal cropland, pasture, and CRP lands. Bioenergy crops have the potential to reduce atmospheric carbon by building up soil carbon levels, especially when planted on lands where soil carbon levels have been reduced by intensive tillage, such as marginal cropland (Andress 2002). In instances where pasture or CRP lands would be converted to switchgrass production, exchanging one system of perennial vegetation for another would be expected to involve minimal environmental changes, including greenhouse gas emissions. A 2007 study (Wang 2007b) concluded that "cellulosic ethanol produced from switchgrass clearly offers the greatest energy and GHG [greenhouse gas] benefits (by far)." Based on these considerations, DOE concludes that in the event switchgrass were to replace corn stover as the dominant feedstock, the net result to greenhouse emissions would be beneficial (that is, use of corn stover in the GREET Model produces conservative results).

Section F.15 in Appendix F of this Abengoa Biorefinery Project EIS contains a more complete discussion of the GREET Model, including its parameters and associated values used in the analysis.

The Abengoa Biorefinery Project would reduce greenhouse gas emissions not only by producing a fuel that displaces gasoline, but also by producing power that displaces electricity from other electricity generating sources. Combining these reductions and other factors into a single metric to express the net effect on greenhouse gas emissions on a lifecycle basis relative to a baseline scenario in which the biorefinery is not built poses a challenge. The relatively large reduction attributable to electric power generation compared with the reduction from gasoline displacement contributes to the challenge. However, the GREET Model accounts for both sources of reduction and generates a relative percentage comparison, which is explained below.

DOE used the GREET Model to compare three scenarios in greenhouse gas emissions with the baseline scenario—(1) vehicles fueled only by ethanol, (2) vehicles fueled by 85-percent ethanol and 15-percent gasoline (E85), and (3) vehicles fueled by 10-percent ethanol and 90-percent gasoline (E10). Based on the GREET Model, the Proposed Action under the first scenario would result in a 306-percent reduction in greenhouse gas emissions compared with the gasoline-only baseline (Roach 2009mm). The reduction in greenhouse gas emissions would be due largely to the emissions credit for the electricity being exported to the grid. The exported biopower would replace electricity that would have been produced largely through coal, nuclear, and natural gas. Thus, the greenhouse gas emissions credit is essentially equal to the difference between the greenhouse gases from producing biomass-based electricity and greenhouse gases from producing coal, natural gas, and nuclear-based electricity. Because the majority of the electricity produced by the Abengoa biorefinery would be exported rather than used for operations, the greenhouse gases displaced by the biorefinery would be larger than the greenhouse gases emitted by biorefinery operations, thus causing a large overall decrease in greenhouse gas (see Appendix F, Section F.15.1). In the second scenario (E85), DOE estimates a 296-percent reduction in greenhouse gas emissions, once again, primarily due to the emissions credit. In the third scenario (E10), DOE estimates that a 26-percent reduction in greenhouse gas emissions could be achieved relative to the gasoline-only baseline (Roach 2009mm).

4.2.1.4 Air Quality Conformity Analysis

The Proposed Action would not trigger transportation *conformity* because it would not require approval through the Federal Highway Administration or Federal Transit Administration. The biorefinery would be a major source of regulated air emissions, but it would be located in an unclassifiable/*attainment* area; therefore, the General Conformity Regulation would not apply either. No further analysis is required to determine if the Proposed Action would trigger the applicability of conformity.

4.2.2 ACTION ALTERNATIVE

Under the Action Alternative, the biorefinery would produce less *denatured ethanol* [12 million gallons (45 million liters)] than the Proposed Action [18 million gallons (68 million liters)] and would not provide electricity to the regional power grid. Only enough power would be generated to operate the biorefinery and syngas would be produced. Because of the reduction in power generation under the Action Alternative, Abengoa Bioenergy would use one smaller solids boiler compared with the larger boilers under the Proposed Action. Since there would be only one boiler and it would be smaller, the emissions from the power generation source group (Table 4-2) under the Action Alternative would decrease. Further, under the Action Alternative, the amount of biomass that would be shipped to and received by the biorefinery would be less than under the Proposed Action, thus reducing the amount of *fugitive dust* emissions from haul roads and biomass receiving. Table 4-7 shows the potential emission summary for the Action Alternative, both with and without proposed controls in place (Salter 2009a).

Table 4-7. Summary of emissions under the Action Alternative.

	Uncontrolled facility-wide emissions		Controlled facility-wide emissions	
Pollutant	Tons per year[a]	Metric tons per year	Tons per year[a]	Metric tons per year
Particulate matter	528.95	479.85	31.74	28.79
PM_{10}	343.16	311.31	25.88	23.48
$PM_{2.5}$	254.42	230.80	23.73	21.53
Nitrogen oxides	1,955.86	1,774.32	313.92	284.78
Sulfur dioxide	464.30	421.20	46.50	42.18
Carbon monoxide	216.78	196.66	216.78	196.66
Volatile organic compounds	2,602.90	2,361.30	58.27	52.86
Single hazardous air pollutant	233.68	211.99	4.67	4.24
Total hazardous air pollutants	268.37	243.46	7.81	7.09

a. Source: Salter 2009a.
PM_{10} = particulate matter with an aerodynamic diameter less than or equal to 10 micrometers.
$PM_{2.5}$ = particulate matter with an aerodynamic diameter less than or equal to 2.5 micrometers.

Applying the potential emissions from the Action Alternative, DOE used the dispersion model with the same receptor points and meteorology data as in the analysis for the Proposed Action. Complete details of the parameters used in the air dispersion model are presented in Appendix F. Table 4-8 lists the results of the dispersion modeling under the Action Alternative. Since the potential emissions under the Action Alternative are less than those under the Proposed Action, the impacts likewise would be less. The impact from the 1-hour averaging time for carbon monoxide would be the same for the Proposed Action and Action Alternative because the source with the largest contribution to that impact is the emergency generator, and the potential emissions from the emergency generator are the same for the two action alternatives. All the modeled concentrations added to the background concentrations are less than the National Ambient Air Quality Standards under the Action Alternative.

Greenhouse Gas from the Action Alternative

Under the Action Alternative, the biorefinery would be a source of greenhouse gases, with carbon dioxide being the most abundant. The boiler would be the main source of carbon dioxide, methane, and nitrous oxide. Carbon dioxide would also be emitted by the biomass fermentation and distillation processes. A summary of the controlled biorefinery greenhouse gas emissions by emission source is shown in Table 4-9.

Table 4-8. Summary of model results under the Action Alternative.

Pollutant	Averaging period	Year of maximum modeled impact[a]	NAAQS[b] ($\mu g/m^3$)	Background[c] ($\mu g/m^3$)	Maximum model increment ($\mu g/m^3$)	Impact ($\mu g/m^3$)
Carbon monoxide	1-hour	2003	40,000	2,300	800	3,100
	8-hour	2004	10,000	570	80	650
Nitrogen dioxide	Annual	2002	100	8.0	4.8	13
Sulfur dioxide	3-hour	2003	1,300[d]	10	34	44
	24-hour	2004	370	8.0	6.7	15
	Annual	2002	78	3.0	0.71	3.7
PM_{10}	24-hour	2004	150	60	14	74
	Annual	2005	Revoked[e]	20	3.0	23

a. Source: 40 CFR Part 50.
b. Source: Lavery 2009.
c. The modeling analysis was completed using five years of processed meteorological data from 2002 through 2006.
d. Secondary standard.
e. The PM_{10} annual standard was 50 $\mu g/m^3$ prior to being revoked by EPA.
NAAQS = National Ambient Air Quality Standards.
PM_{10} = particulate matter with an aerodynamic diameter less than or equal to 10 micrometers.
$\mu g/m^3$ = micrograms per cubic meter.

Table 4-9. Summary of the Abengoa biorefinery greenhouse gas emissions for the Action Alternative.

	Controlled facility-wide greenhouse gas emissions					
	Carbon dioxide		Methane		Nitrous oxide	
Emission Source	Tons per year[a]	Metric tons per year	Tons per year[a]	Metric tons per year	Tons per year[a]	Metric tons per year
Fermentation and distillation process vent	44,053	39,964	0	0	0	0
Biogas flare	52	47	0.001	0.0009	0.0001	0.00009
Syngas Flare	52	47	0.001	0.0009	0.0001	0.00009
Boiler	380,528	345,209	66	60	9.2	8.3
Firewater pump engine	190	172	0.008	0.007	0.002	0.002
Emergency power generator	616	559	0.03	0.03	0.005	0.005
Total	425,491	385,998	66	60	9.2	8.3

a. Source: Salter 2009a.

To evaluate non-carbon dioxide greenhouse gas emissions from the Action Alternative, the mass estimates of the non-carbon dioxide greenhouse gas emissions were converted into a carbon dioxide equivalent value. Table 4-10 presents the non-carbon dioxide greenhouse gas emissions in terms of carbon dioxide equivalents using two sets of global warming potentials: one drawn from the Technical Summary of the Intergovernmental Panel on Climate Change's Fourth Assessment Report (Solomon et al. 2007) and one drawn from the Panel's Second Assessment Report (IPCC 1995). The total greenhouse gas emissions in carbon dioxide equivalents from the Action Alternative, which is shown in the bottom row of Table 4-10, is the sum of the total carbon dioxide from Table 4-9, the total methane in carbon dioxide equivalents from Table 4-10, and the total nitrous oxide in carbon dioxide equivalents from Table 4-10.

Based on the potential emission calculations, the total emissions of carbon dioxide equivalents from the biorefinery would be 430,000 tons (about 390,000 metric tons) per year (Salter 2009a).

Greenhouse gases emitted by the Abengoa biorefinery would mix and be stable in the atmosphere and would not result in any direct impacts to the Hugoton area. The emissions would pose no direct hazard to human health, such as from toxicity or asphyxiation, and any incremental climate change impacts attributable to the relatively small quantities of greenhouse gases that would be emitted under the Action Alternative would be too small to observe, either globally or in the Hugoton area. However, the greenhouse gases the Abengoa biorefinery would emit would add to past and future emissions from all other sources of U.S. and global greenhouse gas emissions, contributing to cumulative impacts on climate change, such as those described in Section 4.2.1.3.2. At present there is no methodology that would allow DOE to correlate greenhouse gas emissions from the Proposed Action to any specific climate change impact.

DOE also applied the GREET Model to the Action Alternative to estimate the level of greenhouse gas emissions reduction compared with the gasoline-only baseline where passenger vehicles use 100-percent conventional and/or reformulated gasoline (Section 4.2.1.3.4). Unlike the analysis described for the Proposed Action (Section 4.2.1.3.4), the GREET Model was configured such that an emissions credit was not assumed for the export of electricity to the grid. Section F.15 in Appendix F contains a more complete discussion, including its parameters and associated values used in the analysis.

The GREET Model was used to compare three scenarios in greenhouse gas emissions with the baseline scenario—(1) vehicles fueled only by ethanol, (2) vehicles fueled by 85-percent ethanol and 15-percent gasoline (E85), and (3) vehicles fueled by 10-percent ethanol and 90-percent gasoline (E10). Based on the GREET Model, the Action Alternative under the first scenario would result in a 39-percent reduction in greenhouse gas emissions compared with the gasoline-only baseline (Van Pelt 2009). In the second scenario (E85), DOE estimates a 33-percent reduction in greenhouse gas emissions. In the third scenario (E10), DOE estimates that a 3-percent reduction in greenhouse gas emissions could be achieved relative to the gasoline-only baseline (Van Pelt 2009).

Table 4-10. Summary of biorefinery carbon dioxide equivalents for the Action Alternative.

	Fourth Assessment Report values[a]				Second Assessment Report values[b]			
	Methane		Nitrous oxide		Methane		Nitrous oxide	
Emission Source	Tons per year	Metric tons per year	Tons per year	Metric tons per year	Tons per year[c]	Metric tons per year	Tons per year[c]	Metric tons per year
Fermentation and distillation process vent	0	0	0	0	0	0	0	0
Biogas flare	0.02	0.02	0.03	0.03	0.02	0.02	0.03	0.03
Syngas flare	0.02	0.02	0.03	0.03	0.02	0.02	0.03	0.03
Boiler	819	743	1,377	1,249	688	624	1,433	1,300
Firewater pump engine	0.19	0.17	0.46	0.42	0.16	0.15	0.48	0.44
Emergency power generator	0.63	0.57	1.51	1.37	0.53	0.48	1.57	1.42
Total of non-carbon dioxide equivalents	820	744	1,379	1,251	689	625	1,435	1,302
	Tons per year		Metric tons per year		Tons per year		Metric tons per year	
Total carbon dioxide equivalents[d]	427,690		387,993		427,615		387,925	

a. The global warming potentials for methane and nitrous oxide are 25 and 298, respectively (Solomon et al. 2007).
b. The global warming potentials for methane and nitrous oxide are 21 and 310, respectively (IPCC 1995).
c. Source: Salter 2009a.
d. Total carbon dioxide equivalents are the sum of the total non-carbon dioxide equivalents (methane and nitrous oxide) and the total carbon dioxide from Table 4-9.

4.2.3 SUMMARY OF AIR QUALITY IMPACTS

The Proposed Action and Action Alternative would be sources of criteria air pollutants as well as greenhouse gas. DOE analyzed four criteria pollutants using an EPA-approved air dispersion model for assessing pollutant concentrations in the *ambient air*. The resulting modeled concentrations were then added to the existing background concentrations for comparison with federal air quality standards. The maximum modeled concentrations used for this analysis resulted in a higher estimated impact because the averaging schemes EPA uses to derive the concentration standards are not based on the highest single concentration. Even with this conservative approach, all model results for the Proposed Action and Action Alternative were well below the National Ambient Air Quality Standards, with the impacts from the Proposed Action resulting in slightly higher values than those from the Action Alternative. Therefore, impacts to air quality in the Hugoton area would be less than levels deemed to be protective of human health and the environment and would not degrade the existing air quality. Emissions would be minimized through control equipment and management practices. The Proposed Action and Action Alternative would be sources of greenhouse gas; however, the production and use of biofuel as opposed to conventional gasoline in either the Proposed Action or the Action Alternative would result in an overall reduction in greenhouse gas, as was shown by the GREET Model analysis.

4.3 Hydrology

This section describes the potential hydrological, that is, surface- and *groundwater*, impacts associated with the Proposed Action and Action Alternative. Section 4.3.1 describes the impacts of the Proposed Action and Section 4.3.2 describes the impacts of the Action Alternative.

4.3.1 PROPOSED ACTION

4.3.1.1 Surface Water

Section 3.4.1 describes the general lack of surface water features within the region of influence. In spite of the lack of surface water features, the manner in which wastewater would be managed and runoff would be accommodated or otherwise affected by the Proposed Action has the potential to impact surface water. The primary impact topics for the Proposed Action are the following:

- The potential for planned and accidental releases of water or contaminants to the ground and to move off the site,
- The potential for changes to surface water runoff and infiltration rates, and
- The potential for altering existing (natural or manmade) surface water drainage.

The second and third impact topics are addressed together because the only surface drainage that could be affected by the Proposed Action is that associated with the movement of runoff. The same discussion addresses potential impacts to *floodplains* and *wetlands*.

Section 3.4.1.1.1 describes the recent history of decreased flow in the Cimarron River as a result of a decline in the High Plains *aquifer*. As Section 4.3.1.2.1 describes, the Proposed Action could result in a decrease in groundwater use by as much as about 5,000 acre-feet (6.2 million cubic meters) per year, comparing projected water demand with approved water rights. This is about 2.4 percent of the 211,000 acre-feet (260 million cubic meters) of water used for irrigation in Stevens County in 2007 (Table 3-6) and about 1.0 percent of the 484,000 acre-feet (600 million cubic meters) of irrigation water used in the four counties (that is, Morton, Stanton, Grant, and Stevens) in the southwest corner of Kansas in 2007 (Table 3-6). The predominant source for irrigation water in all four counties is the High Plains aquifer. It is very unlikely that the difference in groundwater use attributed to the Proposed Action could have any effect on the amount of water flowing in the Cimarron River.

4.3.1.1.1 *Planned and Accidental Releases*

The only wastewater that would be intentionally released during operation of the biorefinery would be non-contact cooling water, which would be used for irrigation in the 425-acre (1.7-square-kilometer) buffer area (Roach 2009h). DOE anticipates that the land application of the non-contact cooling water would require a discharge permit from the Kansas Department of Health and Environment and that monitoring of the water quality would be part of the permit that Abengoa Bioenergy would seek. Use of the non-contact cooling water for irrigation would require construction of an earthen-lined holding pond, sized to hold at least 90 days of maximum discharge to accommodate the generation of the wastewater during winter when temperatures would prevent land application (Roach 2009i). Potential impacts associated with land application of the non-contact cooling water are addressed further in Section 4.6.1 of this EIS, including estimates of the quantities of wastewater that would be generated and the capacity that would be required for a holding pond. The land application and temporary storage of this wastewater would not result in runoff and, other than its temporary storage during months when land application is not feasible, would not result in ponding.

Other wastewater that would be generated by the Proposed Action includes process wastewater and domestic sewage. Process wastewater would be treated onsite and recycled. Domestic sewage would be managed in an onsite septic tank(s), so there would be no surface discharges from the management of this waste stream.

There would be process chemicals and other *hazardous materials* at the biorefinery site during construction and operations that could be released accidently. If such an incident occurred during a precipitation event, the released material could be transported by surface water runoff, but only for a short distance, and it would not reach any stream. Potential contaminants during construction would consist mostly of fuels (diesel and gasoline) and lubricants (oils and grease) for equipment. These materials would be expected to be present only in the equipment in which they were used, but if temporary bulk storage tanks were brought to the site to support construction activities, the tanks would be located in secondary containment as a best management practice.

During operations, hazardous constituents that would be used and stored at the site include acid and *caustic* solutions, liquid ammonia, urea, enzymes, and several other process chemicals (Roach 2009i, 2009j), as well as ethanol, gasoline denaturant, and diesel fuel. These materials would all be stored in tanks with various types of secondary containment (Roach 2009k). According to the draft *Spill Prevention, Control, and Countermeasures Plan* (WLA 2008a) prepared for the biorefinery, bulk fuel storage would be in aboveground tanks within a lined, secondary containment berm, the chemical storage area would be within an area surrounded with a concrete berm, and the emergency power generators would be supported by double-wall fuel tanks. In addition, the tanker loading and unloading area and the *anhydrous* ethanol process areas would have trench drains that led to a concrete containment basin.

Finally, the biorefinery construction area would be designed to drain toward low areas within the Biorefinery Project site. In the unlikely event a hazardous constituent released or spilled during biorefinery operations, and there was a storm event at the same time, any contaminated runoff would flow to those low areas where response actions could be taken. The biorefinery would be designed so that under most storm conditions, no runoff could leave the biorefinery parcel (Roach 2009l). In the event runoff was great enough to flood the low areas within the Project site, overflow would run to adjacent property to the south or to the buffer area to the east. Since these areas are internally drained, there would be no mechanism to move contamination far from the biorefinery site. The referenced Spill Prevention Plan also contains applicable response procedures and reporting requirements should a release of a petroleum product or hazardous chemical occur.

A draft *Storm Water Pollution Prevention Plan for Construction Activities* (WLA 2008b) was prepared to address erosion and sediment control measures and other pollution prevention measures that would be taken at the site during construction. This plan would be finalized and implemented in conjunction with authorization to discharge storm water during construction under a Kansas Water Pollution Control and National Pollutant Discharge Elimination System Storm Water Runoff from Construction Activities General Permit. Planning and procedures developed in both draft plans would minimize the potential for contaminants or sediments to leave the site.

4.3.1.1.2 *Surface Water Runoff Rates, Infiltration Rates, and Drainage Features*

Areas disturbed from biorefinery construction would experience at least temporary changes in the rates of infiltration. Areas where infiltration rates decreased would experience a corresponding increase in surface water runoff. The Proposed Action would disturb about 66 acres (0.27 square kilometer) of the 385-acre (1.6-square-kilometer) biorefinery parcel, including the railroad spur (Roach 2009m). However, once the biorefinery was constructed and disturbed areas not required for operation of the biorefinery were reseeded, the central area where essentially all of the facilities would be located would consist of only about 30 acres (0.12 square kilometer) (Roach 2009n). The land area involved is very small in comparison with the Upper Cimarron-Liberal *watershed* area of 1,720 square miles (4,500 square kilometers) (Chapter 3, Section 3.4.1.1). The biorefinery parcel represents less than 0.04 percent of the entire watershed. However, as noted above, most of the land area around the Biorefinery Project site drains internally, so comparisons with the entire watershed can be misleading. Impacts associated with runoff from the Project site would always be more localized.

The draft storm water plan described above, which is a requirement of the General Permit, will address any best management practices necessary to minimize or control erosion during construction. These practices may include:

- Construction access control measures to minimize the amount of area disturbed,
- Design of cut and fill slopes in a manner that minimizes erosion,
- Use of sediment control measures such as silt fences or straw bale barriers, and
- Protection of culverts from unfiltered or untreated runoff.

Storm water runoff control during biorefinery operations would consist of designed and constructed elements within the built-up area to move runoff toward natural low areas to the southwest and the east. Within the built-up area, surfaces around buildings and structures would be sloped toward roadways where there would be earthen-lined ditches or paved, shallow channels to carry runoff away from the facilities. Culverts would be installed under the roadways as necessary to divert runoff to the desired locations. Culverts, ditches, and swales would be designed to accommodate a 20-year, 20-minute design storm (Roach 2009l).

The two natural low areas, to which runoff would be directed, are within the biorefinery parcel. One is in the central area of the western half of the parcel and the other is at the eastern boundary, adjacent to Road 11, which separates the biorefinery parcel from the buffer area. The low area to the west would catch all runoff from the portion of the biorefinery parcel lying to the west of the railroad spur. Because there would be little construction in this portion of the parcel, there would be little change in the amount of runoff naturally reaching this low area. The low area to the east would catch runoff from the portion of the biorefinery parcel lying east of the railroad spur, which would include most of the built-up area of the biorefinery. This area would collect runoff from about 180 acres (0.73 square kilometer), including most of the 30 acres (0.12 square kilometer) of built-up area. As a result, unless the surrounding soil was already saturated or frozen, this low area would receive larger quantities of runoff than under natural conditions.

For precipitation or snowmelt runoff to overflow the low area to the east of the biorefinery parcel, the level of accumulated water would have to top Road 11, which is several feet higher than the field area along this side of the biorefinery parcel (Roach 2009l). Were this to happen, water would overflow to the east, to the low area in the buffer area. This low area is where runoff currently accumulates in the local area. Under the Proposed Action, this property would continue to be used for agriculture, and minor changes in the amount of run-on would not result in any impacts. As Section 3.4.1.4 describes, this existing area of *intermittent* ponding is unlikely to qualify as a *jurisdictional wetland* and is normally farmed. Corresponding to the possible increase in run-on to the section of buffer area, there would likely be an increase in the amount of infiltration that would occur at that location. However, that increase in infiltration would be offset by a decrease in infiltration in the biorefinery parcel because of the overflowing storm water. The differences in either location would be minor and of no significance in comparison with the infiltration that occurs in the much larger watershed. There should be no effects on surface water runoff and infiltration rates or on surface water drainage on the land areas outside the Biorefinery Project site. Impacts to natural surface water drainage within the two parcels of land would consist of the minor changes to runoff patterns described above.

As Section 3.4.1.4 in Chapter 3 describes, the low area in the buffer area is an existing area of intermittent ponding that is identified as a potential wetland on the National Wetlands Inventory Map. It is unlikely this area qualifies as a jurisdictional wetland, but the results of the wetland survey and assessment (presented in this EIS as Appendix B) performed by Abengoa Bioenergy have been provided to the U.S. Army Corps of Engineers for concurrence or comment. The Proposed Action would result in non-contact cooling water being used to irrigate this low area, and it could result in additional runoff reaching the area. The Proposed Action would not, however, involve any fill or excavation in that area and it would not change its current use, which is for agriculture. As Section 3.4.1.4 further describes, the low areas in both parcels of land could also be considered local flood zones, but they would not be considered important or significant flood areas, and they do not meet the definition of a floodplain. The Proposed Action would result in minor amounts of additional runoff reaching these low areas, but there would be no impacts to the existing use and beneficial values of these areas.

4.3.1.1.3 *Other Potentially Affected Areas*

The only other areas within the region of influence that could possibly have impacts to surface water as a result of the Proposed Action would be the locations of offsite biomass storage. Being within the 30-mile (48-kilometer) region of influence and at locations where agriculture is already active, these storage sites would not be in areas with *perennial* surface water. To serve their intended function, the offsite storage locations would not be in areas of *depressions* where runoff could accumulate during precipitation events and result in intermittent surface water. These sites would consist of undisturbed laydown areas with no permanent structures. Offsite storage activities would not result in adverse impacts to runoff and infiltration in those areas and would not alter existing drainage channels because they would be located away from drainage channels that could overflow or hinder access. Also, there would be no reason to maintain hazardous materials at these offsite storage locations, so there would be no potential for release or spills that could result in surface water contamination.

4.3.2 GROUNDWATER

This section evaluates impacts to the groundwater affected environment as a result of the Proposed Action. DOE also evaluated potential impacts within the 50-mile region of influence from changes in irrigation practices that may result from the production of biomass grown for sale to the biorefinery.

4.3.2.1.1 *Potential Effects on Groundwater Quantity*

The Proposed Action requires water for *consumptive uses* including direct process water and non-contact cooling. The water balance for the biorefinery would be 1,370 gallons (5,200 liters) per minute averaged over time (Roach 2009a). The volume of water required would be approximately 2,120 acre-feet (2.6 million cubic meters) per year. Abengoa Bioenergy intends to treat and recycle wastewater within the biorefinery, discharging only non-contact cooling water at a continuous rate of approximately 230 gallons (870 liters) per minute (Roach 2009a). Assuming continuous operation, an annual volume of approximately 350 acre-feet (0.43 million cubic meters) would be discharged. The net consumptive use for operations covered by the Proposed Action based on the designed water balance would be approximately 1,140 gallons (4,320 liters) per minute, 1,760 acre-feet (2.2 million cubic meters) per year.

The discharged non-contact wastewater would be used for irrigation of biomass test plots on the buffer area of the Biorefinery Project site. The consumptive quantity from secondary use of non-contact wastewater cannot be quantified at this time, and may be mitigated by recharge to the aquifer from potential return flows if used as irrigation water, and from direct recharge from the wastewater holding pond. This impact analysis takes a conservative approach and considers the full operational water demand for the biorefinery of 2,120 acre-feet (2.6 million cubic meters) per year as consumptive use.

Section 4.5 considers potential impacts to the City of Hugoton public utilities and assumes that potable water supply for the biorefinery would be provided by the City. Water demands on the City's utilities that were evaluated in Section 4.5 include potable supply for temporary construction workers, full-time biorefinery employees and families, and potable supply to the biorefinery during operations. DOE determined the Hugoton water system would not be adversely impacted by the increased water demand under the most conservative assumptions.

The potable water requirements for construction and operation of the biorefinery would increase groundwater withdrawals from the High Plains aquifer by the City of Hugoton. As discussed in Section

4.5.1.1.1, the estimate for the construction phase is an additional demand of 50 gallons (190 liters) per minute for temporary residents based on the peak workforce of 250 workers for about 3 months. The demand for temporary construction workers would be less than 50 gallons per minute for the remaining 64 weeks of construction. Also discussed in Section 4.5.1.1.1, the estimated increased potable water demand during operation of the biorefinery for facility employees (43 full-time employees and families) served by the City of Hugoton is a total of 29 gallons (110 liters) per minute. Assuming the biorefinery obtained its potable water from the City of Hugoton, an additional 1 gallon (3.8 liters) per minute would be required. The longer-term demand on the aquifer for potable supply from Hugoton for full-time employees and the biorefinery would be a total of 30 gallons (114 liters) per minute.

As further discussed in Section 4.5.1.1.1, DOE assumed that, during the construction phase, construction workers would be provided bottled water for consumption with no associated additional demand on the City of Hugoton water system. Other water use at the biorefinery during the construction phase would include dust suppression and soil compaction for structural fill. Water for construction-related activities would be provided from nearby water wells to be acquired for biorefinery operations. Water would be brought to the Project site in water tanker trucks until piping from the facility water wells was installed and water was pumped directly to the construction area (Roach 2009o).

Approximately 225,000 cubic yards (172,000 cubic meters) of earthwork-fill would be required for biorefinery construction (Roach 2009a). This volume of soil is expected to include soil moved for cut and fill purposes. Soil used for structural fill would need to be compacted to an optimum design specification, which likely would require the addition of water to reach optimum moisture content for compaction. Abengoa Bioenergy estimates the volume of water needed for construction/earthwork compaction is 15,000 gallons (56,800 liters) per day, or 25 gallons (95 liters) per minute for 10 hours per day of construction (Roach 2009o). Abengoa further estimates the volume of water for dust suppression during construction is 48,000 gallons (182,000 liters) per day, or 80 gallons (300 liters) per minute for 10 hours per day of construction (Roach 2009a). For comparison purposes, the combined 10-hour-per-day rate of 105 gallons (400 liters) per minute for construction water use equates to a total volume of about 100 acre-feet (0.12 million cubic meters), or a continuous rate of approximately 45 gallons (170 liters) per minute used in the 76-week construction phase. This is a conservative estimate considering that (1) construction water use is estimated to occur daily during the 76-week construction phase but the actual work schedule may be 6 days per week, (2) water use for structural fill would not be likely to occur every day of construction, and (3) dust suppression would not be needed during or immediately following precipitation events.

The total volume and rate of water use during construction that would impact the affected environment includes 50 gallons (190 liters) per minute for potable supply for temporary residents and 45 gallons (170 liters) per minute for construction (dust suppression and soil compaction). The sum of this construction water demand is 94 gallons (360 liters) per minute, or 220 acre-feet (0.27 million cubic meters) over the 76-week construction phase. Because the construction water demand would be much less than that required for operation of the biorefinery [1,370 gallons (5,200 liters) per minute, 2,120 acre-feet (2.6 million cubic meters) per year], the conclusions about impacts to groundwater in the following sections also apply to potential impacts during construction. Therefore, construction water use is not further discussed in this analysis.

Table 4-11 summarizes the demand on the High Plains aquifer resulting from the operation of the biorefinery.

Abengoa Bioenergy has optioned existing irrigation water rights for purchase, to be converted to industrial use to satisfy the water demand of the biorefinery. Table 4-12 presents a summary of the optioned water rights. Water rights may have multiple file numbers, reflecting an overlapped allocated rate and quantity from a single supply well.

Table 4-11. Water demand for operation of the biorefinery to be considered in the analysis.

Consumptive demand	Rate [gallons (liters) per minute]	Volume [acre-feet (million cubic meters) per year]
Biorefinery	1,370 (5,200)	2,120 (2.6)
City of Hugoton	30 (110)	46 (0.057)
Total	1,400 (5,300)	2,170 (2.7)

Note: Totals may differ from sums due to rounding.

Table 4-12 specifies the approved rates, quantities, and acres irrigated for the optioned water rights, based on irrigation use. A change in use from irrigation to industrial purposes would need to be approved by the Division of Water Resources in accordance with *Kansas Administrative Regulation* (K.A.R.) 5-5-9. A reduction in the approved quantity would be expected and would be calculated by multiplying the maximum number of acres irrigated in a single year during perfection of the water right (3,430 acres) by the net irrigation requirement for Stevens County as listed in K.A.R. 5-5-12 (1.23 feet per year). This would result in the maximum potential quantity for industrial use of approximately 4,220 acre-feet (5.2 million cubic meters) per year, which is approximately 60 percent of the approved quantity for irrigation use.

Table 4-12. Water rights Abengoa Bioenergy has optioned.

Water right file numbers[a]	Approved rate [gallons (liters) per minute][a]	Approved quantity [acre-feet (million cubic meters) per year[a]	Approved irrigated[b] [acres (square kilometers)]
12,654; 42612; 42860	2,000 (7,600)	1,216 (1.5)	481(1.95)
41,826	2,500 (9,500)	1,038 (1.3)	550 (2.23)
41,769	1,100 (4,200)	248 (0.3)	143 (0.58)
10,889; 24,931	1,755 (6,600)	1,090 (1.4)	320 (1.3)
26,282	2,000 (7,600)	700 (0. 9)	451 (1.83)
728; 11,383	3,195 (12,100)	888 (1.1)	434 (1.76)
10,520	3,000 (11,400)	1,060 (1.3)	555 (2.25)
22,908; 41,202; 42,191	1,900 (7,200)	1,000 (1.2)	500 (2.02)
Total	17,450 (66,100)	7,240 (8.9)	3,434 (13.9)

a. Source: Roach 2009o.
b. Source: KGS 2009.

The optioned water rights are for eight supply wells diverting water from the High Plains aquifer within an approximate 5-mile (8-kilometer) radius of the Biorefinery Project site. Groundwater would be conveyed from the supply wells to the biorefinery through an underground piping system designed to accommodate 2,000 gallons (7,600 liters) per minute. Each well pump would be sized to provide up 850 gallons (3,220 liters) per minute, and would be operated on a rotating basis, spreading the annual raw water requirement over eight different locations (Roach 2009o). The average operating water need for the biorefinery would be 1,370 gallons (5,200 liters) per minute, and it is assumed that the net rate from all eight supply wells combined and averaged over a year would equal the operating water need (1,370 gallons per minute). The biorefinery would have a peak operating rate of 1,600 gallons (6,060 liters) per minute (Roach 2009a). This peak operating rate of 1,600 gallons per minute represents shorter-term periods of higher pumping rates to meet peak operation demand, and there would also be periods where the operating rates would drop to below the average rate of 1,370 gallons per minute. The average rate of 1,370 gallons per minute represents the long-term average operation demand for the biorefinery operations.

The optioned water rights would provide for an annual irrigation withdrawal of approximately 7,240 acre-feet (8.9 million cubic meters) per year, at a combined pumping rate from the eight supply wells of approximately 17,450 gallons (66,000 liters) per minute. The most recent full year of water use data for the subject water rights indicate a combined volume of about 4,240 acre-feet (5.2 million cubic meters) used for irrigation purposes in 2007 (KGS 2009). The annual water use for biorefinery operations would be 2,170 acre-feet (2.7 million cubic meters), which is a 70-percent reduction from that quantity that could be used for irrigation (7,240 acre-feet), and a 50-percent reduction from the quantity actually used for irrigation in 2007 (4,240 acre-feet). Considering a bounding analysis using the peak operational demand of 1,600 gallons (6,060 liters) per minute for an entire year of operation, which is not expected to occur, the resulting quantity would be about 2,500 acre-feet (3.1 million cubic meters), a reduction of nearly 40 percent of the quantity actually used for irrigation in 2007. Therefore, DOE concludes that use of groundwater for operations of the biorefinery would be a beneficial impact to groundwater, as the biorefinery demand would be a reduction over that which would have occurred if the eight wells and associated demand were to have remained as a source of irrigation water.

DOE also considered the potential interference from a pumping well to other water users in the region of influence. When pumping occurs, there is a drawdown of the water table centered on the pumping well with less drawdown occurring incrementally away from the pumped well. This is typically visualized as a circular, funnel-shaped depression around the pumped well with the greatest drawdown at the well itself (Figure 4-3).

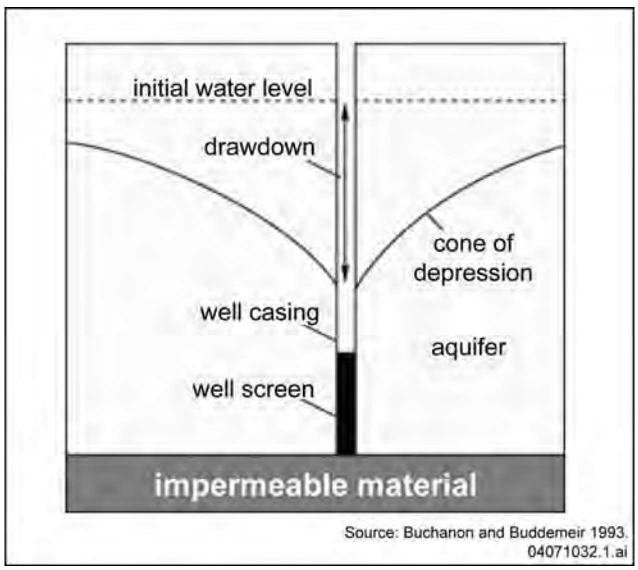


Figure 4-3. General schematic of drawdown and cone of depression.

When approving applications to appropriate water, the Kansas Division of Water Resources and the Groundwater Management District for the area regulate the spacing of wells to minimize interference. The irrigation water rights are established in terms of approved well locations and pumping rates. Changing the use of these wells to supply the biorefinery would result in less pumping at the approved rates and spreading the pumping at lower rates over the area of the wells to be operated. The potential to interfere with nearby operating wells would be reduced by changing the irrigation use to industrial use as discussed.

DOE evaluated the potential for impacts to groundwater from changes in water use patterns within the region of influence. Operations of the biorefinery, which would create a new outlet for biomass from farming operations within the region of influence, could cause changes in cropping practices. Changes in cropping practices could result in changes to irrigation practices, creating additional impact on groundwater.

Biomass feedstock would consist of corn stover, wheat straw, grain sorghum stubble, and switchgrass/CRP, with 89 percent of the feedstock derived from irrigated crops (Roach 2009a). Impacts to groundwater would be caused by increases in production of irrigated crops, namely corn and wheat, and resulting increases in groundwater withdrawal for irrigation. As Section 4.1 discusses, changes in cropping practices as a result of the Proposed Action that would increase or decrease irrigation use of groundwater are not expected to occur. Furthermore, the potential to increase irrigation and increase the impact on groundwater is limited by state water appropriation regulations. Irrigation in Kansas is regulated by the Kansas Department of Agriculture, Division of Water Resources, in addition to local regulation by the Southwest Kansas Groundwater Management District No. 3. In Kansas, most of the area within the region of influence is closed to new groundwater appropriations, except in a few areas in Stevens, Morton and Seward counties that are still open; however, new appropriations would need to meet regulatory *safe yield* requirements to gain approval (KDA 2008). Safe yield requirements generally restrict new appropriations to a quantity not to exceed the annual recharge to the aquifer, taking into account other existing water rights within a 2-mile (3.2-kilometer) radius. Finding an area that would meet safe yield requirements in the areas open to new appropriations in Stevens, Morton or Seward counties would be difficult, if even possible, based on the density of existing water rights in the area and the minimal recharge to the aquifer. Existing irrigation water rights have limits on the maximum rate and quantity of groundwater that can be used on an annual basis. Increases in the amount of water used for irrigation in Kansas as a result of the Proposed Action and associated impacts to the aquifer would be limited accordingly. Irrigation using the non-contact wastewater from biorefinery operations would be considered a secondary use relative to the primary beneficial use for industrial purposes, which would appear to be practicable from a regulatory perspective, and the volume has been accounted for in the operations demand for the biorefinery.

The area of the High Plains aquifer remains open to new appropriations in the Oklahoma panhandle. Per the *Oklahoma Administrative Code* Title 785, Chapter 30, "Oklahoma Water Resources Board, Taking and Use of Groundwater," permits for irrigation must be obtained through the Oklahoma Water Resources Board process. The requirements for new appropriations in the Oklahoma counties would appear to not limit future development of irrigation, except for meeting a minimum spacing of 1,320 feet (400 meters) to other wells and staying within a 2-acre-feet-per-acre (0.6-cubic-meter-per-square-meter) annual maximum quantity.

In Colorado, "Rules and Regulations for the Management and Control of Designated Ground Water 2 CCR 410-1" provides that the area of the High Plains aquifer in Baca County, Colorado remains open to new appropriations. Portions of Baca County within the region of influence are located in the Southern High Plains Designated Groundwater Basin, which requires 0.5-mile well spacing limitations and an annual appropriation quantity of no more than 3.5 acre-feet per acre (1.1 cubic meter per square meter). These rules and regulations have been promulgated pursuant to the *Colorado Groundwater Management Act*, Title 37, Article 90; *Colorado Revised Statutes*, primarily Section 37-90-107, 108, 109, and 111; and rules and regulations governing The Southern High Plains Ground Water Management District.

As mentioned, future irrigation development within the Kansas area of the region of influence is limited. Future development does not appear to be as limited in Oklahoma or Colorado; however, other factors described in Section 4.1.3 would be expected to limit the impact to the aquifer by increased withdrawal associated with changes in cropping practices resulting from the Proposed Action. Thus, DOE concludes that impacts to groundwater from changes in water use related to changes in cropping practices as a result of the Proposed Action would not be expected to occur.

Water use for self-supplied domestic use and municipal use could be affected by the Proposed Action. Self-supplied domestic use could increase with an increase in population; however, the additional number of residents and associated water use has been accounted for in the impact analysis in Section 4.5 of this EIS, and the additional potable water demand would be supplied by the City of Hugoton.

4.3.2.1.2 *Potential Effects on Groundwater Quality*

Potential effects on the quality of groundwater within the region of influence include *point* and *non-point source pollution*. Section 3.4.2 of this EIS discusses point and non-point source effects to groundwater quality. Planned and accidental releases of water or hazardous constituents could occur at the biorefinery, impacting soil, surface water, and potentially groundwater. Planned or accidental releases are addressed in Section 4.3.1.1, which describes regulatory-required containment and spill-prevention activities. If hazardous constituents were released or elevated concentrations of inorganic constituents were found, Abengoa Bioenergy would be required to report to regulatory agencies and make appropriate responses, including remediation of contaminated soil and groundwater. Response measures included in Spill Prevention, Control and Countermeasures plans could allow releases to be mitigated, reducing or eliminating potential impacts to groundwater.

Non-point source pollution of groundwater in the region of influence is associated with the extensive historical and current farming practices and application of pesticides, herbicides, and fertilizers. DOE does not expect non-point source pollution from construction and operation of the biorefinery.

4.3.2.1.3 *Other Potentially Affected Areas*

The options being considered for management of *lignin* include processing lignin from *lignin-rich stillage cake* at an adjacent building, or using the lignin-rich *stillage cake* as fuel for the solid biomass boiler. If biorefinery operations included processing lignin from the stillage cake, there would be an increase in the normal water demand by 20 gallons (76 liters) per minute per 19,000 tons of lignin production from increased blowdown from the boiler and chillers due to a slight increase in load on both with lignin separation (Roach 2008a). The lignin production estimated for the Proposed Action is nearly 45,000 tons per year (Roach 2009a), which would result in an approximate additional water demand of 40 gallons (150 liters) per minute. The process requirements for an adjacent building have not been identified; however, if consistent with the increased water demand for processing as part of the biorefinery operations, the net increase in demand of 40 gallons per minute or approximately 60 acre-feet (0.07 million cubic meters) per year would not be significant, and the change in water use from irrigation to industrial would remain a net reduction of impacts to groundwater. Additional water demand for using the lignin-rich stillage cake as boiler fuel would not be expected.

Switchgrass constitutes approximately 4 percent of the planned biomass feedstock (Roach 2009a). Switchgrass is not perceived as an irrigated crop; however, irrigation to establish a stand of switchgrass is possible in addition to irrigation at key times during the growing season to maintain productivity. It is conceivable that with an increase in switchgrass production within the region of influence, there would be a potential increase in irrigation of switchgrass. However, water appropriation rules and regulations that limit new irrigation water rights in general, or limit application rates and quantities under existing water rights, would suggest an increase in water use from groundwater for increasing irrigation of switchgrass would not be expected to be significant. As Section 4.1.1.1.1 discusses, if switchgrass production increased within the region of influence, currently productive cropland would be expected to remain as productive cropland and not be converted from annual crop production to perennial production, and the increase in switchgrass production would be expected to be limited to marginal cropland. If switchgrass was irrigated in place of corn, wheat, grain sorghum or other grain crops under existing water rights and irrigation systems on productive cropland, the net application rate for switchgrass would be expected to be less than that of grain crops.

4.3.3 ACTION ALTERNATIVE

4.3.3.1 Surface Water

Surface water-related activities and effects from the Action Alternative would be essentially the same as described in Section 4.3.1.1 for the Proposed Action. The total amount of land disturbed would be slightly less, decreasing from 66 to 61 acres (0.27 to 0.25 square kilometer), and the amount of built-up area with impervious (or relatively impervious) surfaces at the completion of construction would be the same as the Proposed Action, that is 30 acres (0.12 square kilometer). The amount of non-contact cooling water would be only about two-thirds of that produced under the Proposed Action, so the size of the winter holding pond could be smaller, but the irrigation process would be the same, though with less water. There would be very few changes in the types and quantities of petroleum products and hazardous chemicals managed at the site and the same management strategies and containment structures would be in place. The basic storm water runoff control strategy would be the same and, as with the Proposed Action, any alteration of surface drainage would be limited to the two parcels of land that make up the Biorefinery Project site. As with the Proposed Action, any potential impacts to surface water associated with the Action Alternative would be minor.

4.3.3.2 Groundwater

This section evaluates impacts to the groundwater affected environment as a result of the Action Alternative. DOE has evaluated potential impacts within the 50-mile (80-kilometer) region of influence.

4.3.3.2.1 *Potential Effects on Groundwater Quantity*

Additional demand on Hugoton’s water system for potable supply to temporary construction workers is estimated to be 45 gallons (170 liters) per minute, as quantified in Section 4.5.2.1.1. The amount of water required for dust suppression and soil compaction (Roach 2009o), and the construction duration (Roach 2009a) is estimated to be 105 gallons (400 liters) per minute for 10 hours a day over a 76-week duration for construction of the biorefinery under the Action Alternative. Water use and impacts to groundwater for the construction phase is shorter term and not significant compared with longer-term operation of the biorefinery. Therefore, the analysis for the Action Alternative does not include water use during construction, consistent with the approach taken for analysis of the Proposed Action, and conclusions about impacts to groundwater resources from operation of the biorefinery in the following sections also apply to potential impacts during construction. The net additional demand on Hugoton’s water supply relates to potable supply for the biorefinery during operations and the biorefinery workforce of 34 individuals plus families assumed to all reside in Hugoton. The additional demand has been estimated at 24 gallons (90 liters) per minute, or 37 acre-feet (0.05 million cubic meters) per year (Section 4.5.2.1.1).

This estimate is about 80 percent of the comparable water demand (additional demand on Hugoton's water supply) for the Proposed Action.

The normal operational demand for the biorefinery under the Action Alternative would be 525 gallons (1,990 liters) per minute for an annual quantity of approximately 812 acre-feet (1.0 million cubic meters) per year (Roach 2009j). Non-contact wastewater discharge would be 115 gallons (440 liters) per minute, or 178 acre-feet (0.22 million cubic meters) per year (Roach 2009j). The net consumptive use for the biorefinery would be 410 gallons (1,550 liters) per minute, or 634 acre-feet (0.78 million cubic meters) per year. For a conservative analysis consistent with that used for the Proposed Action, this analysis assumes that all raw water pumped to the biorefinery represents consumptive use (812 acre-feet per year). This approach is conservative, as the non-contact wastewater would be used for irrigation of biomass test plots, which would be primarily consumptive use notwithstanding recharge to the aquifer gained from irrigation return flows and directly from the wastewater holding pond.

Table 4-13 presents the groundwater demand for construction and operation of the biorefinery for the Action Alternative. Existing irrigation water rights have been optioned for purchase to be converted to industrial use to satisfy the water demand of the biorefinery. Table 4-14 presents a summary of the optioned water rights under the Action Alternative.

Table 4-13. Groundwater demand for operation of the biorefinery under the Action Alternative.

Consumptive demand	Rate [gallons (liters) per minute	Volume [acre-feet (million cubic meters) per year]
Proposed biorefinery	525 (1,990)	812 (1.0)
City of Hugoton	24 (91)	37 (0.05)
Total	549 (2,080)	849 (1.05)

Table 4-14. Water rights Abengoa Bioenergy has optioned under the Action Alternative.

Water right file numbers[a]	Approved rate [gallons (liters) per minute][a]	Approved quantity [acre-feet (million cubic meters) per year][a]	Approved irrigated [acres (square kilometers)][b]
41,769	1,100 (4,160)	248 (0.3)	143 (0.6)
728; 11,383	3,195 (12,100)	888 (1.1)	434 (1.8)
10,520	3,000 (11,400)	1,060 (1.3)	555 (2.2)
Total	7,295 (27,600)	2,196 (2.7)	1,132 (4.6)

a. Source: Roach 2009o.
b. Source: KGS 2009.

Table 4-14 specifies the approved rates, quantities, and acres irrigated for the optioned water rights, based on irrigation use. A change in use from irrigation to industrial purposes would need to be approved by the Division of Water Resources to facilitate the change, as discussed for the Proposed Action. A reduction in the approved quantity would be expected and would be calculated by multiplying the maximum number of acres irrigated during the perfection of the water rights (1,132 acres) by the net irrigation requirement for Stevens County (1.23 feet per year). This would result in the maximum potential quantity for industrial use of approximately 1,400 acre-feet (1.7 million cubic meters) per year, which is approximately 60 percent of the quantity approved for irrigation use.

The optioned water rights would be for three water supply wells within a 2-mile (3.2-kilometer) radius from the biorefinery. Each well would be designed to pump 850 gallons (3,200 liters) per minute and operate on a rotational basis (Roach 2009o). The average operating water need for the biorefinery is 525 gallons (1,990 liters) per minute and it is assumed that the net rate from the three supply wells combined and averaged over a year would equal the operating water need (525 gallons per minute), as the normal operating demand of 525 gallons per minute is assumed to include the short-duration peak operating demand of 790 gallons (2,990 liters) per minute identified for the Action Alternative (Roach 2009j).

The optioned water rights for the Action Alternative would provide for an annual irrigation withdrawal of up to 2,200 acre-feet (2.7 million cubic meters) per year, at a combined pumping rate from the three supply wells of approximately 7,300 gallons (27,600 liters) per minute. The actual water use for these water rights in 2007 was approximately 1,500 acre-feet (1.9 million cubic meters) for irrigation purposes (KGS 2009). The annual water use for the biorefinery would be about 850 acre-feet (1.0 million cubic meters), which is approximately 60 percent less than the quantity that could be used for irrigation (about 2,200 acre-feet), and approximately 43 percent less than the quantity actually used for irrigation in 2007. Considering a bounding analysis using the peak operational demand of 790 gallons (2,990 liters) per minute for the biorefinery, which is not expected to occur, the resulting quantity would be approximately 1,220 acre-feet (1.5 million cubic meters). This is a reduction of about 19 percent of the quantity used from these optioned water rights in 2007 for irrigation use.

The Action Alternative would involve three supply wells operating at 850 gallons (3,200 liters) per minute as opposed to eight supply wells at 850 gallons per minute for the Proposed Action. The lesser pumping over time of the Action Alternative would cause less effect on groundwater and potential interference to nearby water wells than the Proposed Action. DOE concludes that use of groundwater for operation of the biorefinery under the Action Alternative would not adversely affect groundwater supplies from the High Plains aquifer, as the biorefinery demand would be a reduction over that which would have occurred if the three wells and associated demand were to have remained as a source of irrigation water.

Considering the Action Alternative is essentially the Proposed Action without export of energy, DOE would not expect changes to cropping practices and associated water use within the region of influence that were not identified for the Proposed Action. However, the Action Alternative requires less than one-third the biomass feedstock required for the Proposed Action (Roach 2009a, 2009j). Thus, DOE concludes impacts to groundwater from changes in water use related to changes in cropping practices would not be expected to occur under the Action Alternative.

4.3.3.2.2 *Potential Effects on Groundwater Quality*

The potential impacts on groundwater quality under the Action Alternative are essentially the same as those for the Proposed Action. As Section 4.3.1.2.2 discusses, releases of contaminants from biorefinery operations are to be addressed through best management practices such as implementation of a Spill Prevention, Control and Countermeasures plan, and potential regulatory response action to other releases of contaminants. Further, DOE does not expect non-point source pollution from construction and operation of the biorefinery.

4.3.3.2.3 *Other Potentially Affected Areas*

The options being considered for management of lignin include processing lignin from lignin-rich stillage cake at an adjacent building, or using the lignin-rich stillage cake as fuel for the solid biomass boiler. These options were included in the analysis for the Proposed Action in Section 4.3.1.2.3. DOE concluded that additional water demand for using the lignin-rich stillage cake as boiler fuel would not be expected, and there would be no significant impact to groundwater considering the volume of water use for processing lignin from the stillage cake for the Proposed Action. The amount of lignin potentially produced under the Action Alternative, 19,000 tons per year, would be about half that produced under the Proposed Action. Therefore, DOE has concluded there would be no significant impact to groundwater resulting from processing lignin at an adjacent building as a component of the Action Alternative.

As discussed in Section 4.3.1.2.3, switchgrass constitutes approximately 4 percent of the planned biomass feedstock. Switchgrass is not typically perceived as an irrigated crop; however, DOE concluded that irrigation to establish a stand of switchgrass is possible in addition to irrigation at key times during the growing season to maintain productivity. There could be an increase in switchgrass irrigation if switchgrass production increased in the region of influence. Water appropriation rules and regulations limit new irrigation water rights in Kansas and limit application rates and quantities under existing water rights within the region of influence. These limitations suggest that a significant increase in water use from groundwater for increasing irrigation of switchgrass would not be expected. Furthermore, if switchgrass was irrigated in place of corn, wheat, grain sorghum, or other grain crops under existing water rights and irrigation systems, the net application rate for switchgrass would be expected to be less than that of grain crops. As discussed in Section 4.1.1.1.1, if switchgrass production increased within the region of influence, currently productive cropland would be expected to remain as productive cropland and not be converted from annual crop production to perennial production, and the increase in switchgrass production would be expected to be limited to marginal cropland.

4.3.4 SUMMARY OF HYDROLOGY IMPACTS

4.3.4.1 Summary of Potential Surface Water Impacts

The potential for adverse impacts to surface waters from the Proposed Action or the Action Alternative would be very minor, as summarized in the following statements.

- Planned releases of wastewater to the surface are limited to the non-contact cooling water that would be used for irrigation of the buffer area and held in an earthen-lined pond during winter. Petroleum products and hazardous chemicals would be present during construction and operations, but they would be managed within secondary containment and there are no surface waters in the area that would be affected by accidental releases. The potential for adverse impacts from planned or accidental releases would be minor.

- Disturbed and built-up land areas would result in increased runoff, but runoff would be directed to natural low areas within the 385-acre (1.6-square-kilometer) parcel where the biorefinery would be located. Changes in infiltration would be minor and likely would be limited to slight changes in the distribution of where it would occur. Potential impacts from changes in runoff or infiltration would be minor.

- Alterations to surface water drainage would be limited to minor changes within the 385-acre biorefinery parcel and possibly within the associated buffer area and any potential impacts would be minor. Natural low areas where runoff accumulates would not be altered and would not qualify as floodplains. Pending U.S. Army Corps of Engineer concurrence, no jurisdictional wetlands would be affected.

4.3.4.2 Summary of Potential Groundwater Impacts

The direct impacts to groundwater associated with the Proposed Action or Action Alternative include withdrawal of groundwater. The total water demand for the Proposed Action would approach 2,170 acre-feet (2.7 million cubic meters) per year (Table 4-11). This is over 5,000 acre-feet (6.2 million cubic meters) less than the currently approved quantity of approximately 7,240 acre-feet (8.9 million cubic meters) per year for the water rights that would be acquired for the biorefinery. This would be the maximum reduction in groundwater withdrawals, as water rights are established based on maximum annual use during development of the water right, and historical water use data for the subject water rights indicate the volume used has varied from year to year. During the most recent full year for which water use data are available, approximately 4,240 acre-feet (5.2 million cubic meters) were withdrawn for irrigation from the subject water rights (KGS 2009), or over 2,000 acre-feet (2.5 million cubic meters) more than the total demand for the Proposed Action. Groundwater withdrawal rates under the Proposed Action would be reduced from approximately 17,450 gallons (66,000 liters) per minute approved for irrigation use to approximately 1,400 gallons (5,300 liters) per minute (averaged), which includes the additional rate required by the City of Hugoton.

The total water demand for the Action Alternative would be about 850 acre-feet (1 million cubic meters) per year (Table 4-13). This is over 1,300 acre-feet (1.6 million cubic meters) less than the currently approved quantity of approximately 2,200 acre-feet (2.7 million cubic meters) per year for the water rights that would be acquired for the biorefinery. During the most recent full year for which water use data are available, a volume of approximately 1,500 acre-feet (1.9 million cubic meters) was withdrawn for irrigation from the subject water rights (KGS 2009), or approximately 700 acre-feet (0.9 million cubic meters) more than the total demand for the Action Alternative. Groundwater withdrawal rates under the Action Alternative would be reduced from approximately 7,300 gallons (27,600 liters) per minute approved for irrigation use to approximately 525 gallons (1,990 liters) per minute (averaged) for biorefinery operations, which includes the additional rate required by the City of Hugoton.

Section 3.4.2 in Chapter 3 of this EIS describes concerns about sustainability and aquifer depletion for groundwater. The Department concludes that the Proposed Action and Action Alternative would generate a net beneficial impact to groundwater because the quantity of groundwater withdrawn and the rate of withdrawal would be less than that which currently occurs, and could continue to occur, for irrigation purposes.

Comparing the total water demand for the Action Alternative (with that of the Proposed Action, the total water demand for the Action Alternative would be about 1,320 acre-feet (1.6 million cubic meters) less than that for the Proposed Action. However, considering the reduction in water potentially pumped for irrigation by conversion of the water rights from irrigation to industrial use, the Proposed Action would have less of an impact to groundwater than the Action Alternative. This is based on comparing the volume of water actually used for irrigation in 2007 from optioned water rights to the total water demand for the Action Alternative and Proposed Action. The reported 2007 irrigation water use from optioned water rights for the Action Alternative was 1,500 acre-feet (1.9 million cubic meters) and 4,240 acre-feet (5.2 million cubic meters) for the Proposed Action. The total water demand for the Action Alternative would be 850 acre-feet (1.05 million cubic meters) and 2,170 acre-feet (2.7 million cubic meters) for the Proposed Action. This comparison suggests a “savings” in terms of water that would not be withdrawn by changing the use from irrigation of approximately 2,070 acre-feet (2.6 million cubic meters) for the Proposed Action and 650 acre-feet (0.8 million cubic meters) for the Action Alternative. The Proposed

Action creates more of a beneficial impact to groundwater than the Action Alternative considering the volumes actually used for irrigation in 2007 as described. The trend holds true considering the total volume of groundwater that could be withdrawn from the optioned water rights. While it may be specific to Kansas and the proposed approach of acquiring and converting the use of irrigation water rights to industrial, the approximate 40-percent reduction in approved water volume under the optioned water rights suggests the beneficial impact increases with the total volume of optioned water right quantities acquired.

Indirect impacts relate to water use changes in response to changes in cropping and irrigation practices in the region of influence. As discussed in Section 4.1, changes are not expected to occur; however, the net impact, if any, in terms of additional withdrawal from groundwater is not expected to be significant for the reasons stated herein for either the Proposed Action or the Action Alternative.

4.4 Biological Resources

4.4.1 PROPOSED ACTION

To construct the biorefinery, land within the 385-acre (1.6-square-kilometer) parcel of the Biorefinery Project site that currently is used for dry-land farming (Figure 1-2 in Chapter 1) would be converted to industrial use. Some additional land also would be disturbed in that area to construct an electrical power line to the Project site. In addition, there would be an increase in traffic, human activities, and associated potential disturbances within 1 mile (1.6 kilometer) of the Project site. Within the 30-mile (48-kilometer) region of influence, seven offsite biomass storage locations [each 160 acres (0.65 square kilometer)] would be developed on marginal cropland or pastures. Within that region, biomass would be harvested for use at the biorefinery.

4.4.1.1 Flora

All areas within the Biorefinery Project site have been previously developed, are periodically mowed and tilled, and sprayed with herbicides. Adjacent developed areas include the city of Hugoton, an industrial park, improved roads, a railroad, and an airport. Some trees are present around nearby residences as landscape, but no natural woodlands are present. There are no undisturbed areas, native prairies, or other high-quality habitats that could be impacted within or adjacent to the Project site.

Habitat in areas adjacent to the Biorefinery Project site include tilled cropland with smaller amounts of livestock pasture, mowed areas around the golf course and airport, and areas along roadsides and railroads that are periodically mowed or sprayed with herbicides. Some of the areas have some native bluestems, gramas, and wheatgrass present, but are mostly dominated by brome and other non-native species. While still considered relatively poor-quality grasslands, the best habitats present within 1 mile (1.6 kilometers) of the Project site are the rough areas within the golf course, and no changes in golf course management are expected from the Proposed Action.

No facilities would be constructed at the offsite storage locations, and any impacts caused by the Proposed Action would be reversible. The offsite storage locations would be in areas that do not interfere with crop production or irrigation activities, utilize lands that are marginal for crop production, and provide truck access (Section 2.1.2.1.2). Those sites likely would be located on marginal cropland or pastures that have already been disturbed and are adjacent to existing roads.

CRP lands within the 30-mile (48-kilometer) region of influence are a mixture of native plants and introduced agricultural species. CRP lands are temporarily converted cropland, and subsequently are not considered native prairie. The land use analysis conducted for this EIS indicates that conversion of CRP lands to tilled cropland from the Proposed Action is not likely (Section 4.1).

No changes in land use would occur within the Cimarron National Grassland or other *managed lands* within the region of influence that contain important habitat for native *flora* (Section 3.5.5). Herbicide use is not expected to increase substantially from the Proposed Action because there would be few changes in agriculture or other land uses.

No direct or indirect impacts to native flora are expected from the Proposed Action.

4.4.1.2 Fauna

DOE used the Kansas Department of Wildlife and Parks *Subjective Evaluation of Terrestrial Wildlife Habitats* (KDWP 2004) to assess impacts at and within 1 mile (1.6 kilometers) of the Biorefinery Project site. Parameters used to assess quality of habitats included plant species diversity, presence of exotic/invasive species, growth form variations, interspersion of habitat types, spatial relationships to other habitat types and developed areas, land form variations, and level and types of disturbance. Because cropland is the dominant habitat type, DOE used it for the evaluation of wildlife habitats.

Habitat in areas adjacent to the Biorefinery Project site include tilled cropland with smaller amounts of livestock pasture, mowed areas around the golf course and airport, and areas along roadsides and the railroad that are periodically mowed or sprayed with herbicides. Some of the areas have some native bluestems, gramas, and wheatgrass present, but are mostly dominated by brome and other non-native species. While still considered relatively poor-quality grasslands, the best habitats present within 1 mile (1.6 kilometers) of the Project site are the rough areas within the golf course, and no changes in golf course management are expected from the Proposed Action.

Developed areas within 1 mile (1.6 kilometers) of the Biorefinery Project site include the city of Hugoton, an industrial park, improved roads, airport runways, and the railroad tracks. Habitats within 1 mile of the Project site include tilled agricultural lands and pasture/grassland. Crops include corn, soybeans, winter wheat, and sorghum. Other smaller improved areas include those along the railroad berms, mowed areas at the airport, golf course fairways, golf course rough, and road embankments and drainages. There are some trees present as landscape in residential areas and around an abandoned irrigation return water pond, but no natural woodlands. There are no streams and a very limited amount of highly disturbed wetlands present within 1 mile of the Project site. Impoundments and open water are very limited and are often dry in the summer.

Direct impacts to wildlife habitats from the Proposed Action would include the conversion of agricultural lands to industrial use. The Proposed Action would also result in the conversion of irrigated farmland to dry-land farming if agricultural irrigation wells were converted to biorefinery use. Irrigated tracts of land often have different crops in the center pivot area and field corners; conversion from irrigated to dry-land farming may create more *monocultures* and reduce interspersion of crop types. Reduction of irrigated lands may decrease water supplies for wildlife.

Increased mortality of *fauna* could occur near the biorefinery when crossing improved roads and the railroad due to increased traffic. In addition, *noise*, vibrations, dust, and nighttime lights from biorefinery construction and operations may induce stress. Noise, traffic, and light impacts are expected to extend outward approximately 0.5 mile (0.8 kilometer) from the perimeter of the biorefinery; such impacts beyond 0.5 mile from the biorefinery are not expected.

The current cropland habitat rating at the Biorefinery Project site and within 1 mile (1.6 kilometers) of the Project site is “fair” (KDWP 2004). There would be an irretrievable loss of cropland habitat within the 385-acre (1.6-square-kilometer) biorefinery parcel, and the cropland habitat rating would decrease from “fair” to “poor” for areas within approximately 0.5 mile (0.8 kilometer) of the biorefinery (KDWP 2004).

CRP lands within the 30-mile (48-kilometer) region of influence are a mixture of native plants and non-native agricultural species and are used by common wildlife for foraging, cover, and nesting. CRP lands are temporarily converted cropland, and, as such, are not “native” prairie. The land use analysis conducted for this EIS (Section 4.1) indicates that conversion of CRP lands to tilled cropland from the Proposed Action is not expected.

Grazing on the Cimarron National Grassland is not expected to increase. No changes in land use would occur within the Cimarron National Grassland or other managed lands within the 30-mile (48-kilometer) region of influence that contain important habitat for native fauna (Section 3.5.5). Herbicide use is not expected to increase, and exotic species populations are not expected to increase from the Proposed Action because there would be few, if any, changes in agriculture or other land uses.

Neither direct nor indirect impacts to common species of fauna within the 30-mile (48-kilometer) region of influence from the Proposed Action are expected to be significant.

The transmission line that would be constructed from the biorefinery to a substation would connect to an existing overland transmission line. The transmission line to be constructed is along existing public roads in a predominantly agricultural area and would not be located near any large body of water, river, perennial stream, large block of native grassland, or public managed wildlife area. There are no known endangered species or *critical habitat* where the transmission line would be built. Construction of the connecting transmission line is not expected to impact birds or other biological resources.

4.4.1.3 Threatened and Endangered Species

DOE requested information from the U.S. Fish and Wildlife Service concerning threatened species, endangered species, *candidate species*, and designated critical habitat that may occur in the region surrounding the Biorefinery Project site. The Department also requested an environmental review from the Kansas Department of Wildlife and Parks. Table 3-11 in Chapter 3 includes federal- and state-*threatened and endangered species*, federal candidate species, and state *species in need of conservation* that may occur within in the region surrounding the Project site. The Kansas Department of Wildlife and Parks responded that the project would have no effect on threatened and endangered species in Stevens County. The written responses by those agencies are included in Appendix D of this EIS.

Based on the information provided by regulatory agencies and a review of published information (Chapter 3, Section 3.5.4), DOE concludes there are no threatened and endangered species, or their designated critical habitat within 1 mile (1.6 kilometers) of the Biorefinery Project site. Further, construction and operation of the biorefinery would have no impacts on threatened and endangered species or their designated critical habitat.

The black-tailed prairie dog is currently undergoing reevaluation by the U.S. Fish and Wildlife Service for potential listing as threatened or endangered (73 FR 73211, December 2, 2008). There are no known prairie dog colonies on the Biorefinery Project site and no direct impacts to prairie dogs are expected from construction of the biorefinery. However, there is a small black-tailed prairie dog colony approximately 1 mile (1.6 kilometers) west of the Project site. This colony is surviving in an area that already has disturbance from activities associated with being within and/or near an urban area, improved roads, the railroad, agricultural fields, golf course, and an industrial park. It is expected that noise and night light would *attenuate* at that distance, and thus would result in little change in the existing levels of noise and light at the site of the colony. The colony is not located along one of the expected shipment routes to and from the biorefinery, and no impacts from traffic are expected. Thus, DOE concludes that indirect impacts to this relatively small and isolated colony would not be significant.

The lesser prairie chicken is a candidate for listing as a threatened or endangered species. There are no *leks* on the biorefinery parcel or within 1 mile (1.6 kilometers) of the Biorefinery Project site. Further, the Project site is not within the current range of the lesser prairie chicken, and no native prairie considered a suitable habitat is present. DOE concludes that construction and operation of the biorefinery would not result in any direct or indirect impacts to the lesser prairie chicken.

Direct impacts to threatened and endangered species from the offsite biomass storage locations would be avoided by proper screening and placement. The proposed locations for these storage sites would be evaluated for the presence of native prairie; threatened, endangered, and candidate species; critical habitat; and state species in need of conservation (see Table 3-12 in Chapter 3). If necessary, surveys for these species and habitats would be conducted.

The procurement of biomass was evaluated for the potential to cause indirect impacts from the conversion of CRP lands to tilled cropland. CRP lands are higher-quality habitats than tilled cropland for foraging, cover, and nesting habitat for the lesser prairie chicken, black-tailed prairie dog, and other endangered, threatened, and candidate species within the 30-mile (48-kilometer) region of influence. Conversion of CRP lands to tilled cropland has the potential to increase soil erosion and runoff into the Cimarron River and potentially affect threatened and endangered species of fish such as the Arkansas River shiner.

CRP grasslands adjacent to and near sandsage prairie and other native lesser prairie chicken habitats reduce fragmentation, provide buffers from human disturbance, and provide travel and dispersion corridors (FSA 2006a; NRCS 2008a). Adverse impacts from the Proposed Action to the lesser prairie chicken would occur if a substantial amount of CRP lands was converted to tilled cropland. Conversion of CRP lands that are within, adjacent to, and/or within 0.5 mile (0.8 kilometer) of the Cimarron National Grassland, the channel of the Cimarron River and its major tributaries, lesser prairie chicken leks, occupied lesser prairie chicken habitat, black-tailed prairie dog colonies, and/or other designated *critical habitats* would have the greatest potential for adverse impacts.

Conversion of CRP lands to tilled cropland from the Proposed Action is not expected. Further, indirect impacts from CRP land use changes from the Proposed Action in the 30-mile (48-kilometer) region of influence are not expected. In addition, the Proposed Action is not expected to result in land use changes within the Cimarron National Grassland, increase the use of pesticides, or increase exotic species populations within the 30-mile region of influence. DOE concludes that direct or indirect impacts due to the Proposed Action to federally threatened and endangered species, candidate species, and species protected by Kansas State regulations within the 30-mile region of influence are not expected.

4.4.1.4 Needed Permits, Surveys, or Additional Assessments

The Kansas Department of Wildlife and Parks would not require any permits related to threatened and endangered species for the construction and operation of the biorefinery. The offsite biomass storage locations would undergo additional review when specific locations are proposed. This review would include coordination with the Kansas Department of Wildlife and Parks and U.S. Fish and Wildlife Service. DOE would coordinate with the Oklahoma Department of Wildlife Conservation if an offsite accumulation site were located in Oklahoma. The offsite storage locations would not be located on any high-quality native prairie, known lesser prairie chicken leks, black-tailed prairie dog colonies, designated critical habitats for federally threatened and endangered species, or locations known to have State-protected species. If necessary, surveys for those species and habitats would be conducted before biomass accumulation would begin at proposed locations. Recommendations from regulators would be considered, and it is possible that alternate offsite storage locations would have to be selected.

4.4.2 ACTION ALTERNATIVE

The Proposed Action may have impacts that are slightly greater than the Action Alternative, but for biological resources, there are no important differences between the two action alternatives. The differences in biomass harvest, number of biomass accumulation points, onsite construction that would convert cropland to industrial use, and amount of traffic and noise that would be generated by biorefinery operations in the two alternatives are not enough to produce significant differences. Therefore, all of the Department’s conclusions about impacts from the Proposed Action on biological resources also apply to the Action Alternative. The DOE determination that there are no significant adverse impacts for the Proposed Action or Action Alternative requires that the offsite storage locations would not be located on high-quality native prairie, known lesser prairie chicken leks, black-tailed prairie dog colonies, designated critical habitats for federally threatened and endangered species, or locations known to have State-protected species.

4.4.2.1 Flora

As with the Proposed Action, under the Action Alternative, impacts to native flora from offsite storage locations would be avoided by proper screening and placement. Proposed storage locations would be evaluated for the presence of native prairie, *high-quality natural areas*, and threatened and endangered plant species. If necessary, surveys for those species and habitats would be conducted. No changes in land use would occur within the Cimarron National Grassland or other managed lands within the 30-mile (48-kilometer) region of influence that contain important habitat for native flora. Therefore, impacts to native flora within the 30-mile region of influence from the Action Alternative are not expected.

4.4.2.2 Fauna

As with the Proposed Action, under the Action Alternative, conversion of CRP lands to tilled cropland is not expected. No changes in land use would occur within the Cimarron National Grassland or other managed lands within the 30-mile (48-kilometer) region of influence that contain important habitat for native fauna. Therefore, direct or indirect impacts to common species of fauna within the 30-mile region of influence from the Action Alternative are not expected.

4.4.2.3 Threatened and Endangered Species

DOE evaluated the potential for impacts to candidate and listed threatened and endangered species due to the conversion of CRP lands to tilled cropland. As with the Proposed Action, under the Action Alternative, conversion of CRP lands to tilled cropland is not expected; thus, there would be no impacts to threatened and endangered species from CRP land use changes within the 30-mile (48-kilometer) region of influence.

4.4.2.4 Needed Permits, Surveys or Additional Assessments

The offsite storage locations would undergo additional regulatory review when specific locations are proposed. Under the Action Alternative, there could be fewer storage locations, which could result in fewer additional surveys or assessments than for the Proposed Action.

4.4.3 SUMMARY OF BIOLOGICAL RESOURCES IMPACTS

Significant impacts to biological resources including flora, fauna, and *listed species* are not expected from the Proposed Action or Action Alternative. There are no federal- or state-endangered/threatened species within or immediately adjacent to the Biorefinery Project site. There would be some minor short-term adverse impacts during construction and some minor long-term adverse impacts from the operation of the biorefinery, but these impacts would affect only common wildlife species within 0.5 mile (0.8 kilometer) of the Project site. These impacts would not occur throughout the 30-mile (48-kilometer) region of influence, and overall impacts would not be considered significant. The land use analysis conducted for this EIS indicate that conversion of CRP lands to tilled cropland from the Proposed Action or Action Alternative is not expected. DOE does not expect the Proposed Action or Action Alternative to cause indirect impacts to biological resources within the 30-mile region of influence.

4.5 Utilities, Energy, and Materials

This section describes the potential utilities, energy, and materials impacts associated with the Proposed Action and Action Alternative. Section 4.5.1 describes the impacts of the Proposed Action and Section 4.5.2 describes the impacts of the Action Alternative.

4.5.1 PROPOSED ACTION

This section discusses potential impacts to utilities, energy, and construction materials from construction and operation of the biorefinery. Impacts to water, sewer, and sanitation services addressed in this section are those associated with the increased population that is assumed to live in Hugoton during construction and operation of the biorefinery. Process water, sewer, and *solid waste* would be managed independently at the Biorefinery Project site and are not considered utility issues. Section 4.6 of this EIS addresses impacts of wastes and wastewater generated at the biorefinery, and Section 4.3 addresses impacts from process water usage at the biorefinery. Potable water use at the biorefinery would be obtained from the City of Hugoton water utility and is, therefore, addressed in this section. The analysis in this section primarily compares needs (demand) with available capacity.

4.5.1.1 Utilities

The evaluation of impacts to utilities is based on the assumption that all population growth that would be attributed to the Proposed Action would be experienced in Hugoton. This is a conservative assumption because spreading the population increase over other communities as well as Hugoton would dilute the impact on utilities. The *socioeconomics* evaluation of this EIS (Section 4.9.1) assumes the workforce associated with the Proposed Action would be absorbed within the socioeconomic four-county region of influence (that is, Morton, Seward, and Stevens counties in Kansas and Texas County in Oklahoma); however, the evaluation concludes it is not feasible to predict specific residential distribution patterns within that region. The socioeconomic evaluation further reasons that most of the workforce-associated population increase would be expected to be in Liberal, Kansas, and Guymon, Oklahoma, because those two communities currently have about 60 percent of the total population of the four counties. Strictly from a standpoint of where the added population would be located, the scenario used in the socioeconomics evaluation is considered a more realistic one than described in this section. It is very likely that the number of temporary and permanent residents involved in the Proposed Action would not be accommodated within Hugoton, both as a matter of space availability and individual preference (some workers would simply look to larger communities). But it is reasoned that assuming all utility demands occur in Hugoton is a more conservative condition that would tend to magnify impacts because Hugoton is smaller than Liberal or Guymon and the impacts to utilities experienced in Hugoton would be greater than in Liberal or Guymon, were these communities to take a representative portion of the population increase. For example, were a combined 60 percent of the population increase evaluated in this section to go evenly to Liberal and Guymon, each would see an estimated maximum population increase of 145 people. This would represent 0.7- and 1.4-percent increases to the year 2000 populations of about 19,700 and 10,500 (Chapter 3, Section 3.10.1) for Liberal and Guymon, respectively. It is likely that utilities of either of these communities could readily absorb additional loadings associated with population increases of this size.

The evaluations in this section address only those population increases that would be attributed to the Proposed Action. This is consistent with the assumption that all of the population growth occurs in Hugoton, because the future population of Stevens County is projected to decrease slightly (see Chapter 3, Section 3.10.1). Therefore, there is no basis for assuming population growth other than that associated with the Proposed Action.

4.5.1.1.1 *Water*

The City of Hugoton provides drinking water to its residents and businesses located within and around the city limits. As indicated in Chapter 3, Section 3.6.1.1, the water system currently has an excess capacity of 190 gallons (720 liters) per minute. During construction of the biorefinery, DOE estimates a peak of 250 workers for a short period (the workforce would be over 200 people for only about 3 months) (Roach 2009p). For purposes of this analysis, DOE assumes 75 percent of these workers would be from outside the area and would stay in vacant housing units, seasonal housing, motels/hotels, or bring in trailers or recreational vehicles. Further, this analysis assumes 70 percent of the in-migrating workers would bring their families and that the average family size would be 3.25 persons, including the worker. Using these assumptions, the maximum increase in the area’s population during construction would be about 480 people. The average water consumption in Hugoton is about 302 gallons (1,140 liters) per capita per day, but this value would be unrealistically high for temporary residents, many living in motels/hotels or trailers, and most of whom would not be taking care of permanent residences and the associated activities such as watering lawns. The analysis for this resource area assumes that each of these new, temporary residents would require about 150 gallons (570 liters) of water per day. This rate of water consumption is often used for estimating water demands for city residents. It is less than the 252 gallons (950 liters) per capita per day reported for the western quarter of Kansas over the period from 2003 through 2007 (Chapter 3, Section 3.6.1.1), but is higher than the average use rate of 123 gallons (470 liters) per day per capita reported for all of Kansas over the same period (KWO n.d.). For 480 individuals, the 150-gallon daily rate equals 72,000 gallons (273,000 liters) per day, which equates to 50 gallons (190 liters) per minute. Since the Hugoton water system has an excess capacity of 190 gallons (720 liters) per minute, the system would not be adversely impacted by the increased water demand during construction.

There would be no other additional demand on the Hugoton water system during construction of the biorefinery. It is assumed that bottled water would be brought into the construction site to provide drinking water to the workers, and other water uses such as dust control and soil compaction would be met using water pumped from the wells that would be owned by Abengoa Bioenergy (and which are addressed in Section 4.3.2).

During operation of the biorefinery, there would be as many as 43 full-time employees (Roach 2009p). In this case, the conservative assumptions are that all 43 people would be in-migrating and would live in Hugoton, with an average family of 3.25 members, and would use the same amount of water as current Hugoton residents [that is, 302 gallons (1,140 liters) per capita per day]. With about 140 new residents, the increased water demand would be about 42,300 gallons (160,000 liters) per day, or 29 gallons (110 liters) per minute. Assuming the biorefinery would obtain its potable water from the City of Hugoton (process water would be obtained from biorefinery wells), this would be an additional water demand to supply the needs of the 43 employees. At an assumed water demand of 50 gallons (190 liters) per person per workday, this equates to an average additional demand of 1 gallon (3.8 liters) per minute. Thus, the total for the added residents and the potable water needs of the biorefinery workforce would be about 30 gallons (115 liters) per minute. Even with the conservative assumption of having all employees living in Hugoton, the water system, with a current excess capacity of 190 gallons (720 liters) per minute, would not be adversely impacted.

4.5.1.1.2 *Sewer*

Potential impacts to the sewer utility are evaluated in terms of the sewage collection system and the sewage treatment system. During construction, it is assumed that portable toilet units at the construction site and units in trailers and recreational vehicles used as living quarters by the construction crew would be periodically unloaded to the sewer system. These actions would be done at the sewage treatment lagoons or at other City-approved locations expected to have the least impact on the collection system. The Hugoton sewage collection system currently serves existing facilities within the city and it would not be necessary to expand the system to accommodate the increased population in homes, rental units, and motel rooms during construction. The three lift stations within the City's collection system provide surge capacity in the system to accommodate increased flows that would be attributed to increased population in the town. The integral pumps would have to cycle more often, but other adverse impacts to the collection system would not be expected. So there would be no adverse impacts to the collection system from actions during construction. During operations, the biorefinery sewage would be managed in a septic tank(s) with waste being periodically pumped out and transported to the sewage treatment lagoons or at other City-approved locations expected to have the least impact on the collection system. Since the workforce would be less than during construction, there would be no adverse impacts to the collection system as a result of biorefinery operations.

The City of Hugoton sewage treatment lagoons were designed to accommodate a population of about 4,000, which is compared with current city population of about 3,400 people (USCB 2008a). Using the same rationale and assumptions described in the preceding section, there could be as many as 480 additional people residing in Hugoton for about three months during peak biorefinery construction activities. This would put the population contributing to the sewage treatment facility at just under 3,900 people, which is close to the intended capacity of the treatment lagoons. However, as noted previously, it is expected that the large portion of this additional population would be living in motel/hotels, trailers, and recreational vehicles. It is expected that sewage production from these types of facilities would be less than from individuals living in their homes. In many of the workforce's living locations, clothes washing, dish washing, and similar types of wastewater-producing activities would not be as convenient as in a residential setting and would not be expected to occur as frequently.

During biorefinery operations, the new population would be expected to be about 140 people as derived in the preceding section. This number of new residents would not cause flows to exceed the sewage treatment lagoon's design capacity. Construction and operation of the biorefinery would not cause adverse impacts to the City of Hugoton's sewer system and sewage treatment capabilities. During construction, sewage flow could approach the design capacity of the lagoons, but the increased flow would not cause the lagoons to exceed design parameters for required retention times, and the conditions would be relatively short in duration. During operations, sewage flow to the lagoons would remain well below the lagoons' design capacity.

4.5.1.1.3 *Sanitation Services*

As noted in Chapter 3, Section 3.6.1.3, the Stevens County landfill received an average of 11 to 13 tons (10 to 12 metric tons) of solid waste per day from 2004 through 2007. In 2008, an average of 13.3 tons (12.1 metric tons) per day was disposed of in the landfill. This excludes a large volume of one-time waste that went into the landfill in September 2008, as described in Section 3.6.1.3. The evaluation in this discussion is based on the assumption that the recent, average value of 13.3 tons per day of solid waste going to disposal is representative of the current Steven's County landfill operations.

Stevens County population in 2005 was about 5,300 people. If it is assumed that the amount of solid waste going to the landfill is directly proportional to the number of people in the county, the 480 additional residents during peak construction employment would result in a 9.1-percent increase in solid waste disposal. That is, the average disposal rate of 13.3 tons (12.1 metric tons) per day would increase to 14.5 tons (13.2 metric tons) per day. This does not take into account the lower-than-average solid waste production rates that would be expected for the added construction population that would be in temporary living quarters. During operations of the biorefinery, the 140 additional residents would represent a 2.6-percent increase over the 2005 population and the average disposal rate would be about 13.6 tons (12.3 metric tons) per day.

The existing Stevens County landfill has sufficient capacity to accommodate the added waste associated with population increases from the Proposed Action. However, with the addition of solid waste generated from construction and operation of the biorefinery (addressed in Section 4.6), the County would face a regulatory problem if disposal requirements reached an average of 20 tons (18 metric tons) per day. If that disposal rate were to be exceeded, the County would have to reconsider the landfill's operating permit and potentially face losing its exemption from specific design and monitoring requirements. Upgrading the landfill to meet requirements for a Subtitle D landfill (without exemptions) would represent a significant added expense for the County. Representatives of Stevens County indicated that, if necessary, they might be able to reduce the amount of waste going into the landfill by pursuing more recycling. They also noted, however, that although the Stevens County landfill cannot accept waste from outside the county, solid waste transfer stations in Ulysses (Grant County) and Liberal (Seward County) take waste from outside their counties for a tipping fee (Leonard and Olivier 2008).

4.5.1.2 Energy

4.5.1.2.1 *Electrical Power*

This analysis estimates that during normal biorefinery operations, the co-generation component of the facility would provide 70 megawatts of electrical power to the regional transmission grid (Roach 2009q). During peak internal demand, more of the electricity produced would be used by the biorefinery. It is estimated that during these periods, the biorefinery would still be capable of delivering 60 megawatts of electrical power to the grid. These values can be compared with the City of Hugoton's capability to produce approximately 21 megawatts when sufficient power cannot be obtained from the grid and with the current combined capability of Sunflower Electric Power Corporation and Mid-Kansas Electric Company to produce almost 1,300 megawatts. Finally, the biorefinery's electric power production can be compared with the average summer demand of 41,000 megawatts within the entire Southwest Power Pool. The projected additional power from the biorefinery would represent 5.4 percent of the production capacity in the western-central region of Kansas, but only 0.17 percent of current summer demand in the Southwest Power Pool.

The Southwest Power Pool has operated with summer *capacity margins* of 9.2 to 18.9 percent during the past 10 years with an average summer capacity margin of 14.4 percent (DOE 2009). The capacity margin is expected to remain at 14.1 to 15.9 percent through 2012 (DOE 2009). These values need to be considered in the context that the Southwest Power Pool requires its members to maintain a minimum 12-percent capacity margin to ensure service reliability. Further, if the region does not establish its own margin level, the North American Electric Reliability Corporation assigns a 13-percent capacity margin for predominantly thermal systems (NERC 2009) such as those of the Southwest Power Pool. The Southwest Power Pool predicts that through 2017 there will be a 1.7-percent annual growth in peak energy consumption in the region and a 1.5-percent annual increase in energy production capabilities (NERC 2009). That is, production growth will not keep pace with demand growth. The Southwest Power Pool further predicts that by 2014, the capacity margin will drop below the required 12 percent and reach 11.5 percent. Based on these projections, it can be concluded that there will be continued demand for the electrical power that would be produced by the biorefinery under the Proposed Action, even if that production is only a minor portion of the regional demand.

The electrical co-generation component of the biorefinery would require the installation of approximately 1.5 miles (2.4 kilometer) of high-voltage transmission line to reach from the Biorefinery Project site to the nearest electrical substation of regional grid system. This transmission line and the associated power poles that would be installed are addressed as construction materials in Section 4.5.1.3, but are not otherwise addressed as utility or energy considerations.

4.5.1.2.2 *Natural Gas*

Construction of the biorefinery would not be expected to involve any significant natural gas use. For operations, DOE estimates that the biorefinery would require natural gas at a peak rate of about 2.25 million cubic feet (64,000 cubic meters) per day and at a rate of 1.0 million cubic feet (28,000 cubic meters) per day during normal operations (Roach 2009j). The Hugoton area, where the biorefinery would be constructed, is in one of the country's major natural gas production areas. In 2007, about 370,000 million cubic feet (10,500 million cubic meters) of natural gas were produced and sold in Kansas, which equates to about 1,010 million cubic feet (28.6 million cubic meters) per day. The peak demand and the demand during normal operations would be 0.22 and 0.099 percent, respectively, of this quantity. Of the total amount of natural gas produced in Kansas in 2007, 286,000 million cubic feet (8,100 million cubic meters) were used in the state. The peak demand and the demand during normal operations would be 0.29 and 0.13 percent, respectively, of the amount of natural gas used in Kansas. The minor amounts of natural gas required by the Proposed Action would not impact the availability of natural gas in the region.

4.5.1.2.3 *Other Fossil Fuels and Petroleum Products*

The biorefinery would require diesel fuel during operations to support biomass procurement, onsite rolling stock, the onsite fire water pump, and onsite emergency generators. It is estimated that diesel consumption would be about 1.79 million gallons (6,800 cubic meters) per year (Roach 2009i). As described in Chapter 3, Section 3.6.2.3, Kansas contributes about 2 percent of the crude oil produced in the United States and also has about 2 percent of the nation's crude oil refining capacity. The biorefinery's requirement for diesel fuel is very minor compared with the state of Kansas's annual petroleum refining capacity of about 4,700 million gallons (18 million cubic meters) and the state's annual petroleum product consumption rate of about 3,500 million gallons (13.2 million cubic meters). The biorefinery's demand for diesel fuel would not impact the region's supply and distribution of petroleum products.

DOE has not identified significant use of any other fossil fuels and petroleum products. Gasoline required for the biorefinery process would be stored at the facility. This process gasoline is added to ethanol as a denaturant before it leaves the site for transport to a customer. That is, the gasoline is not consumed in the process, but rather is returned to the market. Therefore, use of this gasoline would not have an impact on, nor is it considered an element of, energy or material resources.

4.5.1.3 Construction Materials

Table 4-15 provides a summary of the types and quantities of materials that would be required to construct the biorefinery. DOE has identified alloy and stainless steel pipes, fittings, and equipment as the only construction materials for which there would be a relatively high risk of unavailability in the market (Roach 2008b). Steel tanks and process piping entries are the items likely to be made of stainless steel and, therefore, the items most likely to pose availability issues. Assuming that a 2-inch (5-centimeter) diameter, Schedule 40 pipe is reasonably representative of the process piping that would be necessary, then each linear foot of pipe would weigh about 3.7 pounds (1.7 kilograms) (ASME 2004). The steel tank and process piping entries in the table thus total a need for about 2,500 tons (2,300 metric tons) of stainless steel. Another 2,500 tons of structural steel would be needed to support construction. Because these materials are not manufactured in the region of southwest Kansas, they would be procured from broader, regional markets and possibly from national or even world markets.

Steel production in the United States in 2007 was approximately 107 million tons (97 million metric tons) (USGS 2008). The 5,000 tons (4,500 metric tons) of steel needed to construct the biorefinery would be a minor percentage (less than 0.005 percent) of the country's production capacity. Materials that could be more apt to affect the availability of stainless steel would be the additives used to make the stainless steel, such as chromium and nickel. Nickel is the more scarce of the two and can make up 10 percent or more of common stainless steel formulations (for example, Types 316 and 304 stainless steel). The U.S. Geological Survey *Mineral Commodity Summaries 2008* (USGS 2008), a primary reference for mineral commodities in the United States, provides no U.S. production values for nickel, but rather lists "W," which indicates the values were withdrawn to avoid disclosure of proprietary data. This indicates

Table 4-15. Summary of required construction materials under the Proposed Action.

Description	Quantity	Unit of measure
Structural steel	2,500	Tons
Steel for tanks	2,400	Tons
Concrete	50,000	Cubic yards
Earthwork – fill	225,000	Cubic yards
Asphalt paving	38,000	Square feet
Storm sewer pipe	2,000	Linear feet
Internal and external water pipe	35,000	Linear feet
Railway tracks	9,000	Linear feet
Rock sub-ballest	6,000	Cubic yards
Mechanical process piping	51,000	Linear feet
Painting	40,000	Square feet (of coverage)
Electrical and control cables	166,000	Linear feet
Cable trays	13,000	Linear feet
Fencing	20,000	Linear feet
Gravel	56,000	Cubic yards
Firewater piping	6,000	Linear feet
High-voltage transmission line	7,900	Linear feet
Wooden power poles	18	Each

Sources: Roach 2009i, 2009q, 2009r, 2009s.
Notes: To convert tons to metric tons, multiply by 0.90718. To convert cubic yards to cubic meters, multiply by 0.76456. To convert square feet to square meters, multiply by 0.092903. To convert feet to meters, multiply by 0.3048.

U.S. production is limited and values could easily be tied to a specific production company (or companies). It is also noted in the reference that there were no active nickel mines in the United States in 2007. The only quantities of nickel identified as entering the U.S. market are imports [at about 138,000 tons (125,000 metric tons) in 2007] and purchased scrap [at about 228,000 tons (207,000 metric tons) in 2007 of which about 131,000 tons (119,000 metric tons) were recovered during the year]. The world market for nickel is characterized as just meeting demand in spite of the world's nickel mine production being at an all time high in 2007 (USGS 2008). The amount of nickel necessary to support the biorefinery's construction material needs would be minor in comparison with the amount in the U.S. market, but components such as nickel may be a controlling factor in the general availability of stainless steel.

4.5.2 ACTION ALTERNATIVE

Under the Action Alternative, the biorefinery would not include an electrical co-generation component, but would include a smaller (20 megawatt) electrical generation capacity to support internal power requirements. The biorefinery would produce the same quantity of ethanol, but because there would be no large co-generation capability, the amount of biomass processed would be significantly less and the size of the operation and facilities would be reduced. Accordingly, the size of the construction and operations workforces would be reduced. This section discusses potential impacts to utilities, energy, and construction materials from construction and operation of the biorefinery under the Action Alternative. The evaluation approach and assumptions are basically the same as described above for the Proposed Action.

4.5.2.1 Utilities

The Action Alternative would require an estimated peak workforce of 224 persons during construction and an average workforce of 34 persons during operations. Using the same basis and logic as described above for the Proposed Action, the maximum population increase in Hugoton during construction would be about 430 people, and the population increase during operations would be about 110 people. The following summaries of impacts to utilities are based on these values.

4.5.2.1.1 *Water*

During construction, it is assumed that water demand by each of these more temporary residents would be about 150 gallons (570 liters) per day. For the 430 additional people this equates to 64,500 gallons (244,000 liters) per day, or about 45 gallons (170 liters) per minute, well within Hugoton's excess capacity of 190 gallons (720 liters) per minute. This estimated demand is 90 percent of that for the Proposed Action and, similarly, the Hugoton water system would not be adversely impacted by increased water demand during construction.

During operations, it is assumed that per capita water demand for the additional population of 110 people would be no different than that for the current Hugoton population, which is about 302 gallons (1,140 liters) per day per person. This water demand along with the estimated 50 gallons (190 liters) per workday for the biorefinery workforce of 34 persons equates to about 34,000 gallons (130,000 liters) per day or an average of 24 gallons (91 liters) per minute. This is about 80 percent of the comparable water demand estimated for the Proposed Action and, similarly, would not adversely impact the Hugoton water system.

4.5.2.1.2 *Sewer*

As with the water discussion, estimates of sewage production are based on the population increases as a result of the Action Alternative. The maximum population increase during construction (about 430) added to the existing Hugoton population of 3,400 people would have a combined sewage production of less than the design capacity of the sewage treatment lagoons, which is for a population of 4,000 people. The increased sewage production during construction would be about 90 percent of that estimated for the Proposed Action and, similarly, would not overload the sewage treatment lagoons. During operations, the sewage loads attributed to the increased population of 110 people would be well within the design capacity of the sewage treatment lagoons.

4.5.2.1.3 *Sanitation Services*

The amount of solid waste added to the Stevens County landfill under the Action Alternative also would be directly related to the estimated population increases. During construction, the Stevens County population of about 5,300 would increase by about 430 people, or 8.1 percent. Applying this percentage increase to the average landfill disposal rate of 13.3 tons (12.1 metric tons) per day results in an estimated rate of 14.4 tons (13.1 metric tons) per day. During operation of the biorefinery under the Action Alternative, the additional 110 residents would represent a 2.1-percent increase in the county population, and the average disposal rate would be about 13.6 tons (12.3 metric tons) per day. The existing Stevens County landfill has sufficient capacity to accommodate the added waste associated with population increases from the Action Alternative.

4.5.2.2 Energy

4.5.2.2.1 *Electrical Power*

Without the larger electrical co-generation component, the biorefinery would have to draw from the electrical grid to satisfy internal power needs rather than provide power to the grid. This power requirement would be in addition to that supplied by the 20-megawatt generator that would remain as part of the Action Alternative. This analysis estimates the peak demand for additional electrical power during biorefinery operations would be about 15 megawatts and the average additional demand would be about 10 megawatts (Roach 2009t). These values can be compared with the City of Hugoton's capability to produce approximately 21 megawatts when sufficient power cannot be obtained from the grid and with the combined capability of the Sunflower Electric Power Corporation and the Mid-Kansas Electric Company to produce about 1,300 megawatts. Finally, the biorefinery's electric power needs can be compared with the average demand of 41,000 megawatts within the entire Southwest Power Pool.

As Section 4.5.1.2.1 describes, the Southwest Power Pool is currently operating with a reasonable capacity margin and is expected to stay within the required minimum of 12 percent for the next 5 years. However, estimates of power demand increases and power production increases indicate the summer capacity margin could drop to 11.5 percent by 2014 (NERC 2009). This is only a small increment below what is considered a safe margin to ensure system reliability, and during winter months, when demand is historically lower, a power generation capacity margin of about 30 percent is expected to be the norm (DOE 2009). The Southwest Power Pool is evaluating alternate internal and external means to increase power production, but the additional load associated with the Action Alternative would be minor in any case. The average electrical demand of the biorefinery would be about 0.77 percent of the Sunflower Electric and Mid-Kansas Electric current combined production capacity and about 0.024 percent of the average electrical demand within the Southwest Power Pool. The biorefinery's peak demand would represent slightly higher percentages, but neither the peak nor average electrical needs would represent significant increased demands to the regional distribution system. Clearly, the biorefinery could not expect the City of Hugoton's electrical power production capabilities to provide any notable portion of its power needs.

4.5.2.2.2 *Natural Gas*

Construction of the biorefinery under the Action Alternative would not require any significant natural gas use. For operations, DOE estimates the biorefinery would require natural gas at a peak rate of about 1.4 million cubic feet (40,000 cubic meters) per day and at a rate of 0.2 million cubic feet (5,700 cubic meters) per day during normal operations (Roach 2009j). As noted previously, the Hugoton area is in one of the country's major natural gas production areas and, in 2007, about 370,000 million cubic feet (10,500 million cubic meters) of natural gas were produced and sold in Kansas. This production equates to about 1,010 million cubic feet (28.6 million cubic meters) per day, so the peak and normal demand during operations would be 0.14 and 0.02 percent, respectively, of this quantity. Of the total amount of natural gas produced in Kansas in 2007, 286,000 million cubic feet (8,100 million cubic meters) were used in the state. The peak and normal demands during operations would be 0.18 and 0.026 percent, respectively, of the amount of natural gas used in Kansas. It can be concluded that the minor amounts of natural gas required by the Action Alternative would not impact the availability of natural gas in the region.

4.5.2.2.3 *Other Fossil Fuels and Petroleum Products*

The Action Alternative would require diesel fuel during operations to support biomass procurement activity, onsite rolling stock, the onsite fire water pump, and onsite emergency generators. It is estimated that diesel consumption would be about 794,000 gallons (3,000 cubic meters) per year (Roach 2009i). The biorefinery's requirement for diesel fuel under the Action Alternative is very minor compared with the state of Kansas's annual petroleum refining capacity of about 4,700 million gallons (18 million cubic meters) and the state's annual petroleum product consumption rate of about 3,500 million gallons (13.2 million cubic meters). The biorefinery's demand for diesel fuel would not impact the region's supply and distribution of petroleum products. Gasoline would be present in the biorefinery process and would be stored at the facility, but its use as a denaturant for the ethanol is not consumptive and it is returned to the market.

4.5.2.3 Construction Materials

Table 4-16 provides a summary of the types and quantities of materials that would be required for construction under the Action Alternative. Also included in the table is the percent change for each of the

Table 4-16. Summary of required construction materials under the Action Alternative.

Description	Quantity	Unit of measure	Percent change from Proposed Action
Structural steel	2,200	Tons	-12
Steel for tanks	2,400	Tons	0
Concrete	35,000	Cubic yards	-30
Earthwork – fill	210,000	Cubic yards	-6.7
Asphalt paving	38,000	Square feet	0
Storm sewer pipe	2,000	Linear feet	0
Internal and external water pipe	35,000	Linear feet	0
Railway tracks	9,000	Linear feet	0
Rock sub-ballast	6,000	Cubic yards	0
Mechanical process piping	45,000	Linear feet	-12
Painting	22,500	Square feet (of coverage)	-44
Electrical and control cables	155,000	Linear feet	-6.7
Cable trays	12,000	Linear feet	-7.7
Fencing	20,000	Linear feet	0
Gravel	48,000	Cubic yards	-14
Firewater piping	6,000	Linear feet	0

Source: Roach 2009q, 2009r.

Note: To convert tons to metric tons, multiply by 0.90718. To convert cubic yards to cubic meters, multiply by 0.76456. To convert square feet to square meters, multiply by 0.092903. To convert feet to meters, multiply by 0.3048.

items in comparison with that estimated for the Proposed Action. As can be seen in the table, for all materials, the necessary quantity would either stay the same or decrease. The table does not include the high-voltage transmission line and power poles identified for the Proposed Action because those materials are associated with the electrical co-generation component. Alloy and stainless steel items would be the only construction materials for which there could be a relatively high risk of unavailability in the market (Roach 2008b). The steel tanks and process piping entries in the table are the items likely to be stainless steel and, therefore, the items most likely to pose availability issues. The quantity of stainless steel required for the tanks would remain the same as for the Proposed Action, but the quantity of stainless steel piping would decrease by 12 percent. Making the same assumption that a 2-inch (5-centimeter) diameter, Schedule 40 pipe is reasonably representative of the process piping [with each linear foot of pipe weighing about 3.7 pounds (1.7 kilograms)], the total amount of stainless steel required would decrease from about 2,500 tons (2,300 metric tons) under the Proposed Action to 2,480 tons (2,250 metric tons). The amount of structural steel that would be required under the Action Alternative would also decrease by 12 percent.

Since the amount of required stainless steel would change very little from that of the Proposed Action, it is expected that impacts to the market and availability of materials from the Action Alternative would be the same as for the Proposed Action. That is, the amount of nickel necessary to support the biorefinery's construction material needs would be minor in comparison with the amount in the U.S. market, but components such as nickel may be a controlling factor in the general availability of stainless steel.

4.5.3 SUMMARY OF UTILITY, ENERGY, AND MATERIAL IMPACTS

4.5.3.1 Utilities

The evaluation of impacts to utilities includes the conservative assumption that all of the in-migrating workforce and their families, for both construction and operations, were to reside in Hugoton. Even with this assumption, DOE reached the following conclusions with respect to the Proposed Action and the Action Alternative:

- Additional water demand associated with the increased population would be within Hugoton's existing capacity to provide water, during both construction and operations;
- Additional sewage production would not overload Hugoton's sewer collection system, and with the additional loading, the existing sewage treatment lagoons still would be within their design capacity; and
- Solid waste production associated with the increased population would only involve minor increases to the amount of waste going to the Stevens County landfill, and the landfill has adequate capacity.

Were the population increases associated with the construction and operations workforces spread out—with most going to the larger communities of Liberal, Kansas, and Guymon, Oklahoma—potential effects to utilities of those areas would be expected to be less than those described for Hugoton.

4.5.3.2 Energy

The Proposed Action would require no electrical power from the regional grid during biorefinery operations, but rather would supply electricity to the grid. Under the Action Alternative, the biorefinery would require supplemental electrical power from the regional grid. The amount required would be a small portion (less than 1 percent) of the combined production capacity of Sunflower and Mid-Kansas Electric in the local region and a smaller portion (about 0.024 percent) of the average electrical demand within the Southwest Power Pool. The additional electrical needs would be a negligible increase relative to the existing demands on the regional distribution system.

Under the Proposed Action and the Action Alternative, the amount of natural gas and diesel fuel required for operation of the biorefinery would represent only small increases (only fractions of a percent in all cases) to the amounts of these items already used within the state of Kansas and would not adversely impact the region’s supply and distribution of these fuels.

4.5.3.3 Construction Materials

Both the Proposed Action and Action Alternative would involve a commitment of building materials. With the possible exception of stainless steel, there would be no availability issues, and the needs would not stress the regional market for these materials. Components used in stainless steel production (such as chromium and nickel) are in high demand and sometimes present availability issues. However, the amount of stainless steel that would be required for construction of the biorefinery under either action alternative is a very small portion of the amount of stainless steel that moves through the U.S. market on an annual basis.

4.6 Wastes, Byproducts, and Hazardous Materials

This section describes the potential waste, byproducts, and hazardous materials impacts associated with the Proposed Action and Action Alternative. Section 4.6.1 describes the impacts of the Proposed Action and Section 4.6.2 describes the impacts of the Action Alternative.

4.6.1 PROPOSED ACTION

The wastes and byproducts the biorefinery would produce include construction wastes, wastewater, *solid biomass boiler ash*, distiller’s residual biomass solids (stillage cake), *stillage syrup*, wastewater treatment facility sludge, lignin, *genetically modified organisms*, dirt and *fines* resulting from biomass processing, municipal solid waste, and *hazardous waste* (Roach 2009u).

Solid biomass boiler ash and lignin are byproducts that could be sold to consumers within the 50-mile (80-kilometer) region of influence. Abengoa Bioenergy would burn stillage cake, stillage syrup, and genetically modified organisms in the biorefinery solid biomass boiler as part of the Proposed Action. Domestic and process wastewater would be treated in the onsite wastewater treatment facilities and treated process wastewater would be recycled in the ethanol production process. Abengoa would apply non-contact wastewater and wastewater treatment facility sludge on the 425-acre (1.7-square-kilometer) buffer area, and would treat, recycle, and/or dispose of dirt and fines resulting from biomass processing, municipal solid waste, hazardous waste, and construction debris generated by the biorefinery at permitted facilities within the region of influence (Roach 2009u).

4.6.1.1 Construction Waste

Wastes requiring offsite disposal would be generated during the 18-month construction phase of the biorefinery. Table 4-17 lists the anticipated construction wastes. Abengoa Bioenergy would manage excess construction materials to minimize wastes. Excess construction materials would be returned to vendors, retained for future use, or transferred to subcontractors by negotiation. Abengoa Bioenergy would recycle construction material scraps, as feasible, to reduce solid waste disposal. However, the waste quantities listed in Table 4-17 are total projected wastes and do not include reductions due to recycling. The biorefinery construction and disposal facility operation schedules would allow for approximately 300 workdays per year, totaling 450 workdays during the construction phase. Therefore, averaged over 450 operating days, the average estimated weight of construction wastes generated would be 78 tons (71 metric tons) per day. Further, the estimated solid waste generated due to the increase in worker population during the construction phase is approximately 1.2 tons (1.1 metric tons) per day (Section 4.5.1.1.3).

Table 4-17. Construction wastes requiring offsite disposal.

Type of waste	Quantity/Volume
Ground excess, construction, and demolition debris	1,980,000 cubic feet, or 73,300 cubic yards (56,040 cubic meters) @950 pounds per cubic yard = 34,800 tons (31,600 metric tons)
Plastics, papers, and cartons	13,200 pounds, or 6.6 tons (6 metric tons)
Steel waste, pipes, and cables (trimmings and wastes)	132,000 pounds, or 66 tons (60 metric tons)
Metal cans (painting, chemical, and oil)	26,400 pounds, or 13.2 tons (12.0 metric tons)
Municipal solids (inorganic)	178,200 pounds, or 89.1 tons (80.8 metric tons)

Source: Roach 2009v.

The non-recycled construction wastes listed above would be disposed of in active permitted solid waste disposal facilities located in Kansas in accordance with K.S.A. 65-34. Three active, permitted *municipal solid waste landfills* and one *construction and demolition waste landfill* are located within 35 miles (56 kilometers) of the Biorefinery Project site. Permitted municipal solid waste facilities in Kansas are allowed to receive the construction wastes listed above. The wastes meeting the Kansas definition of *construction and demolition waste* (under K.S.A. 65-34) could also be disposed of at the construction and demolition landfill.

The Stevens County landfill must not receive more than 20 tons (18 metric tons) per day (based on annual average) to maintain its exempt status as a small arid landfill. If that disposal rate were to be exceeded, the County would have to revisit the landfill's operating permit and potentially face losing its exemption from specific design and monitoring requirements. Upgrading the landfill to meet requirements for a Subtitle D landfill (without exemptions) would present a significant added expense for the County. Based on this analysis, DOE concludes that the Stevens County landfill would not have adequate capacity to receive the construction wastes generated during the Proposed Action and maintain its small arid landfill exempt status.

The Morton County municipal solid waste landfill does not accept waste from outside Morton County. The annual average tonnage of waste received at the Seward County municipal solid waste landfill near Liberal, Kansas, is 75,000 tons (68,000 metric tons) (KDHE 2008). The Grant County construction and demolition landfill has the capacity and could receive the construction wastes meeting the Kansas definition of construction and demolition waste. Solid waste transfer stations in Ulysses (Grant County) and Liberal (Seward County) take waste from outside their counties for a tipping fee (Leonard and Olivier 2008). The non-recycled construction waste stream could be split among various permitted landfills and transfer stations within the region of influence and the bulk of the construction and demolition waste could be received by the Grant County construction and demolition landfill. Splitting the construction waste among landfills would require permission from the selected facilities to receive the wastes. To mitigate impacts to disposal facilities within the region of influence, the development of a waste management and pollution prevention plan should be considered prior to contracting the biorefinery construction. Abengoa Bioenergy should identify landfills for the disposal of solid waste and industrial wastes generated during construction and operations of the biorefinery. Construction specifications should direct contractors where to recycle and/or dispose of construction-generated wastes.

4.6.1.2 Wastewater

This section describes impacts associated with wastewater generated by the biorefinery during operations. Table 4-18 presents the projected wastewater that would be produced at the biorefinery.

4.6.1.2.1 *Onsite Treatment Facility*

The onsite wastewater treatment facility at the biorefinery would treat all process wastewater generated at the site and would not discharge any to the Hugoton wastewater system. The biorefinery would produce 250 gallons (950 liters) per minute (normal design flow) of wastewater that would be treated onsite and reused in the process. The system would be designed to treat an operating peak flow of 300 gallons (1,140 liters) per minute (Roach 2009w). The wastewater treatment facility would employ *anaerobic* (without oxygen) and *aerobic* (with oxygen) digesters. Treated wastewater would be recycled to the *enzymatic hydrolysis* process (Roach 2009w).

Table 4-18. Wastewater that would be produced at the biorefinery.

Wastewater	Volume-normal operations [gallons (liters) per minute]	Treatment
Sewage (during construction and operations)	See Section 4.5.1.1.2	Portable toilets during construction Septic tank and drainage field during operations
Process wastewater	250 (950)	Wastewater treatment facility and reuse in the process
Non-contact wastewater (outfall)	225 (852)	Land application on buffer area (total of the four sources listed below)
Reject water from reverse osmosis	40 (150)	
Softener regeneration water	1 (4)	
Boiler blowdown water	16 (61)	
Cooling tower bleed water	168 (636)	

Source: Roach 2009w.

4.6.1.2.2 *Land Application*

Wastewater that would not be recycled and reused in the ethanol production process or treated in the onsite wastewater treatment system would be discharged from a combined discharge outfall, referred to as "Outfall." As outlined in the water balance process (Roach 2009w), the sources of discharge to the Outfall would be reject water from the reverse osmosis process, softener regeneration water, boiler blowdown water, and cooling-water tower blowdown water, for a total of 225 gallons (852 liters) per minute (normal design flow). The system would be designed to handle an operating peak flow of 520 gallons (1,970 liters) per minute (Roach 2009w). Abengoa Bioenergy would use a land application process to treat the wastewater from the Outfall (Roach 2008c). This water would be used to irrigate biomass crops on the buffer area (Roach 2009x). DOE anticipates that the land application of the Outfall discharge water would require a discharge permit in accordance with the Kansas Department of Health and Environment *Minimum Design Standards for Water Pollution Control Facilities* (KDHE 1978).

The ability of vegetation and soil to absorb and utilize the wastewater without adverse effects generally determines the maximum application rates. The discharge permit would stipulate the maximum allowable application rates. Abengoa Bioenergy has not yet completed the discharge permit application for submission to the Kansas Department of Health and Environment but has contracted an *agronomy* study, which is a requirement of the permit application process.

Monitoring of the water quality and properties would be part of the permit that Abengoa Bioenergy would seek. The wastewater from the Outfall would have the characteristics outlined in Table 4-19. Maximum allowable application rates would be determined by the Kansas Department of Health and Environment.

There are no set regulatory limits for specific constituents of wastewater applied for agricultural purposes in Kansas (KDHE 1978). Plant uptake and crop harvesting would facilitate removal of the primary nutrients, nitrogen and phosphorus, from the site. Other constituents not removed from the site by harvest would tend to accumulate in the soil. The agronomy study will analyze the impacts of the discharge on soil and vegetation. These impacts would be addressed in the discharge permitting process.

Table 4-19. Water quality for non-contact wastewater discharge Outfall.

Parameter	Units	Outfall
pH	standard units	NA
Conductivity	µmhos/cm	2,637
TOC	mg/L	NA
P-Alkalinity ($CaCO_3$)	mg/L	NA
M-Alkalinity ($CaCO_3$)	mg/L	693
Bicarbonate alkalinity	meq/L	NA
Bromide	mg/L	NA
Chloride	mg/L	101
Fluoride	mg/L	2
Nitrate	mg/L	14
Nitrite	mg/L	NA
Total phosphorus	mg/L	NA
Total phosphate	mg/L	NA
Total inorganic phosphate	mg/L	NA
Dissolved ortho phosphate	mg/L	NA
Reactive silica	mg/L	112
Sulfur (SO_4)	mg/L	724
Total hardness ($CaCO_3$)	mg/L	1,073
Calcium hardness	mg/L	678
Magnesium hardness	mg/L	395
Aluminum	mg/L	NA
Arsenic	mg/L	0.0
Barium	mg/L	0.08
Beryllium	mg/L	0.00
Boron	mg/L	0.54
Cadmium	mg/L	0.00
Chromium	mg/L	0.00

Table 4-19. Water quality for non-contact wastewater discharge Outfall (continued).

Parameter	Units	Outfall
Cobalt	mg/L	0.00
Copper	mg/L	NA
Iron	mg/L	NA
Lead	mg/L	0.00
Manganese	mg/L	0.04
Molybdenum	mg/L	0.00
Nickel	mg/L	0.04
Potassium	mg/L	13.17
Selenium	mg/L	0.0
Sodium	mg/L	151.02
Strontium	mg/L	4.65
Thallium	mg/L	0.00
Tin	mg/L	0.23
Titanium	mg/L	0.04
Vanadium	mg/L	0.04
Zinc	mg/L	0.31
Temperature	degrees Fahrenheit	NA
Flow capacity of stream	gallons per minute	376
Total dissolved solids	mg/L	2,001

Source: Roach 2009w.
meq/L = milliequivalents per liter.
mg/L = milligrams per liter = parts per million.
NA = not applicable.
μmhos/cm = micromhos per centimeter.

A holding pond would be required for storage of at least 90 days of maximum discharge [29,160,000 gallons (110,380 cubic meters)] to accommodate the generation of the wastewater during months when the outside temperature would prevent land application (Roach 2009a). The holding pond would be located on the southeast portion of the biorefinery parcel (Roach 2009y). Land application and temporary storage of wastewater would not result in runoff and, other than its temporary storage during months when land application was not feasible, would not result in ponding. If the Outfall discharge rate were to exceed the permitted maximum allowable application rate, the water would be diverted to the storage pond and subsequently applied to the buffer area.

Based on the *hydrology* analysis, the chemical composition of the wastewater, and the requirements of the Kansas Department of Health and Environment *Minimum Design Standards for Water Pollution Control Facilities* (KDHE 1978), DOE does not anticipate adverse impacts from the land application of the Outfall wastewater.

4.6.1.2.3 *Treatment of Lignin-rich Stillage Cake*

Abengoa Bioenergy is considering two options for handling the lignin in the lignin-rich stillage cake that would be generated during distillation in the enzymatic hydrolysis process. The first option is to convey the lignin-rich stillage cake to an onsite third-party lignin producer (Roach 2009i). The second option is to forego lignin extraction and convey the lignin-rich stillage cake to the solid biomass boiler for use as fuel for energy recovery.

4.6.1.2.4 *Lignin Treatment Option 1*

The enzymatic hydrolysis process would decant the lignin-rich stillage and evaporate the thin stillage to create concentrated thin stillage syrup. The wet stillage cake would be about 65-percent moisture by weight prior to lignin extraction. If the first option for handling lignin is selected, the onsite lignin producer would extract the lignin from the stillage cake and convey the lignin-poor stillage cake back to the biorefinery for use as fuel to the solid biomass boiler. The wet lignin-poor stillage cake would return to the biorefinery at about 60-percent moisture by weight prior to burning in the solid biomass boiler. The extracted lignin would be shipped offsite by the third-party lignin producer for use as a beneficial byproduct such as a replacement for phenol as a wood binder in the production of particle board (Roach 2009u). Wastewater generated during the lignin extraction process would be conveyed back to the biorefinery for treatment in the onsite wastewater treatment system. The lignin extraction process would include: (1) adjusting the stillage pH to solubilize the lignin, (2) separating the soluble lignin stream from the solids (salt/ash), (3) adjusting the pH of the soluble lignin stream to precipitate the lignin, and (4) separating the insoluble lignin from the liquid stream. The wastewater stream from this process, which would include the filtrate generated in the fourth step, would be approximately 394 gallons (1,490 liters) per minute and contain a salt concentration of 2.12 percent by weight. The wastewater stream could also be concentrated using a reverse osmosis process and recycling the separated water, resulting in a total flow of 79 gallons (300 liters) per minute with a salt concentration of 10 percent by weight (Roach 2009i). The lignin extraction wastewater would be in addition to the process wastewater treatment flow listed in Table 4-18. This wastewater would be treated and reused in the ethanol production process. The water balance and wastewater treatment facility design would require modification if this lignin extraction option was exercised.

4.6.1.2.5 *Lignin Treatment Option 2*

The second option for handling the lignin-rich stillage cake is to forego lignin extraction and convey the lignin-rich stillage cake to the solid biomass boiler for use as fuel for energy recovery. This option would not generate wastewater in addition to the process wastewater treatment flow listed in Table 4-18.

4.6.1.3 Wastes and Byproducts Management

Table 4-20 presents the projected wastes and byproducts the biorefinery would produce. Dirt and fines resulting from biomass processing and municipal solid waste, including construction debris generated during the operations phase of the biorefinery, would be disposed of as waste at permitted facilities within 35 miles (56 kilometers) of the Biorefinery Project site. Based on an operating schedule of 350 days per year, there would be 96 tons (87 metric tons) per day of dirt and fines and 0.1 ton (0.09 metric ton) per day of municipal solid waste. Further, the estimated solid waste generated due to the increase in population during the operations phase is approximately 0.3 ton (0.27 metric ton) per day (Section 4.5.1.1.3). The total solid waste stream from these sources equals approximately 96.4 tons (87.5 metric tons) per day. This additional solid waste would increase the waste stream to the Stevens County landfill from 13.3 tons (12.1 metric tons) per day to approximately 109.7 tons (99.5 metric tons) per day. Based on these observations, DOE concludes there is not adequate capacity at the Stevens County landfill to receive the solid waste generated during the operations phase of the biorefinery without modification of its small arid landfill exempt status. The Stevens County landfill cannot receive waste from outside the county and Stevens County can deny waste streams as necessary to maintain the landfill’s exempt status as a small arid landfill. The estimated lifetime of the Seward County landfill is 42 years, based on receipt of 75,000 tons (68,000 metric tons) per year of waste. If all the biorefinery operations phase waste was disposed of at this landfill, the Proposed Action operations phase waste disposal would reduce the life of the permitted landfill space by about 13 years. The operations phase solid waste stream could be split among various permitted landfills and transfer stations within the region of influence. Splitting the operations phase solid waste among landfills would require permission from the selected facilities to receive the wastes. To mitigate impacts to disposal facilities within the region of influence, Abengoa Bioenergy should develop a waste management and pollution prevention plan and identify landfills for the disposal of solid waste and industrial wastes generated during the operations phase of the biorefinery.

Table 4-20. Waste and byproducts that would be produced at the biorefinery.

Waste/Byproduct	Annual quantity	Treatment
Dirt and fines resulting from biomass processing	33,600 tons (30,500 metric tons)	Permitted solid waste disposal facility
Municipal solid waste and construction debris	33 tons (30 metric tons)	Permitted solid waste disposal facility
Wastewater treatment facility sludge	7.5 to 10 gallons per minute (28.4 to 38 liters per minute)	Land application – buffer area
Hazardous waste	1 ton (0.9 metric ton)	Hazardous waste treatment/disposal facility
Distiller's residual biomass solids (stillage cake)	116,550 dry tons (105,730 metric tons)	Feedstock for the biorefinery solid fuel boiler
Distiller's syrup	25,550 dry tons (23,180 metric tons)	Feedstock for the biorefinery solid fuel boiler
Lignin	44,709 tons (40,559 metric tons)	Lignin-rich stillage cake extraction (option 1)
Genetically modified organisms	Included in stillage cake and syrup	Feedstock for the biorefinery solid fuel boiler
Solid biomass boiler ash	79,671 tons (72,276 metric tons)	Value-added nutrient replacement (option 1) Permitted solid waste disposal facility (option 2)

Source: Roach 2009a.

Approximately 7.5 to 10 gallons (28.4 to 38 liters) per minute (about 65-percent moisture) of wastewater treatment facility sludge would be generated during biorefinery operations. This sludge would result from the anaerobic digestion process and consist of dead anaerobic bacteria, related wastes, and inorganics (Roach 2009u). This sludge would be applied on the Biorefinery Project site buffer area. DOE anticipates that this land application of the sludge would require a discharge permit in accordance with the Kansas Department of Health and Environment *Minimum Design Standards for Water Pollution Control Facilities* (KDHE 1978). The discharge permit would stipulate the maximum allowable application rates. Abengoa Bioenergy has not yet completed the discharge permit application for submission to the Kansas Department of Health and Environment but has contracted an agronomy study, which is a requirement of the permit application process. The agronomy study will analyze the impacts of the discharge on soil and vegetation. These impacts will be addressed in the discharge permitting process.

Based on the anticipated composition and quantity of the sludge, DOE does not anticipate adverse impacts from the land application of the wastewater sludge. The Kansas Department of Health and Environment will require that its permit conditions are met.

The biorefinery would generate approximately 2,000 pounds per year (or 76 kilograms per month) of hazardous waste (Roach 2008a). Potential hazardous waste streams include gasoline, spent solvents, laboratory packs, paint wastes, used oil, waste ethanol, acids, caustics, cleaners, waste lamps, and batteries. These wastes would be collected and treated and/or disposed of by licensed hazardous waste facilities near the Biorefinery Project site. The hazardous waste disposal contractors identified closest to the Project site are in Dodge City and Wichita, Kansas. The hazardous wastes generated by the biorefinery would be picked up monthly and managed at the selected 10-day transfer facility. The wastes would then be tested, packaged, labeled, and manifested prior to transport to the selected treatment/disposal facility. All hazardous wastes generated by the biorefinery would be treated by incineration or disposal at the selected treatment/disposal facility. Kansas hazardous waste generators must comply with K.A.R. 28-31-4, "Standards for Generators of Hazardous Waste." The Kansas Department of Health and Environment provides guidance to Kansas hazardous waste generators (KDHE 2006). DOE does not anticipate adverse impacts from the handling, incineration, and/or disposal of hazardous wastes generated by the biorefinery if Abengoa Bioenergy's proposed hazardous waste management practices are implemented. The ultimate treatment/disposal facilities associated with the 10-day transfer facilities in Dodge City and Wichita, Kansas, have ample capacity to treat the relatively minor quantities of hazardous waste that would be generated by biorefinery operations.

Abengoa Bioenergy would burn raw biomass [1,828 dry tons (1,658 dry metric tons per day)], stillage cake [up to 116,550 dry tons (105,730 dry metric tons) per year], thin stillage syrup [25,550 dry tons (23,180 metric tons) per year], and genetically modified organisms in the biorefinery solid biomass boiler. The stillage cake and thin stillage syrup are residues from the enzymatic hydrolysis distillation process. The genetically modified organisms would be used in the enzymatic hydrolysis process. These organisms would be killed by a heat sterilization process and would be contained in the beer column bottoms. The bottoms stream would be dewatered, and the residual solids would be sent to the solid biomass boiler for burning. The solid biomass boiler would generate 79,671 tons (72,276 metric tons) per year of ash. If lignin was not extracted from the lignin-rich stillage cake (Section 4.6.1.2.5), approximately 1,730 tons (1,570 metric tons) per year of additional ash would be generated by the solid biomass boiler.

4.6.1.3.1 *Solid Biomass Boiler Ash (option 1)*

The solid biomass boiler ash [79,671 tons (72,276 metric tons) per year] would contain the majority of the phosphorus and potassium present in the biomass (Roach 2009u). Abengoa Bioenergy would market and sell the ash byproduct to biomass producers as a lower-cost, value-added nutrient replacement co-product. The biomass producers would be located within 50 miles (80 kilometers) of the Biorefinery Project site and would be under contract with Abengoa to produce the biomass (Roach 2009b). Abengoa would pelletize the ash and temporarily store it on the biorefinery parcel until it is trucked to a fertilizer supplier facility. The ash pellets would be blended with nitrogen and additional phosphorus and potassium (as necessary) to provide custom fertilizer mixtures as requested by farmers (Roach 2009q). While under contract to produce the biomass, the biomass producers would not be obligated to purchase the nutrient replacement ash. However, if Abengoa sold the nutrient replacement ash, it would not require disposal as solid waste in a permitted solid waste disposal facility.

4.6.1.3.2 *Solid Biomass Boiler Ash (option 2)*

If none of the solid biomass boiler ash was sold as a nutrient replacement byproduct, 228 tons (207 metric tons) per day (based on an operating schedule of 350 days per year) of additional solid waste would be produced, requiring disposal at a permitted solid waste disposal facility. If lignin was not extracted from the lignin-rich stillage cake before burning in the solid biomass boiler, approximately 5 additional tons (4.5 metric tons) per day of ash would be generated from the solid biomass boiler. Similar to the discussion regarding the disposal of solid wastes generated during the construction phase of the biorefinery (Section 4.6.1.1), the Stevens County landfill would not have the capacity to receive this quantity of ash without a permit modification. Solid waste transfer stations in Ulysses (Grant County) and Liberal (Seward County) take waste from outside their counties, and permitted landfills within the region of influence have the capacity to receive this waste stream. The estimated lifetime of the Seward County landfill is 42 years, based on receipt of 75,000 tons (68,000 metric tons) per year of waste. If all the ash [233 tons (211 metric tons) per day] was disposed of at this landfill, the Proposed Action ash disposal would reduce the life of the permitted landfill space by about 22 years. This estimate does not include the potential loss of landfill space associated with receipt of biorefinery operations phase wastes (Section 4.6.1.3). Therefore, this landfill would not have the capacity to receive all of the ash during the estimated 30-year life of the biorefinery without expansion of the permitted landfill space. This waste stream could be split among various permitted landfills and transfer stations within the region of influence, in which case permission would be needed from the selected facilities to receive the waste.

4.6.1.4 Hazardous Materials Management

Abengoa Bioenergy has estimated the types and amounts of chemicals required for the biorefinery operations. Chemicals required for operation of the biorefinery are presented in Table 4-21. The quantities in this table include a 12-percent overdesign factor (gasoline includes a 10-percent overdesign factor).

Table 4-21. Chemicals required for operations.

Chemical	Annual quantity
Sulfuric acid (94%)	3,542 tons (3,213 metric tons)
Sodium hydroxide caustic (50%)	1,430 tons (1,300 metric tons)
Aqueous ammonia (20%)	6,677 tons (6,057 metric tons)
Urea (42%)	570 tons (520 metric tons)
Cellulase	14,836 tons (13,459 metric tons)
Corn syrup	12,690 tons (11,510 metric tons)
Lime ($Ca(OH)_2$)	6,723 tons (6,099 metric tons)
Corrosion inhibitor (DCI-11®)	47 gallons (178 liters) per year
Magnesium hydroxide (50%)	122.5 tons (111.1 metric tons)
Diammonium phosphate	5.25 tons (4.76 metric tons)
Gasoline (ethanol denaturant)	882,000 gallons (3,340 cubic meters) per year
Limestone	7,362 tons (6,679 metric tons)

Source: Roach 2009a.

Figure 4-4 shows the locations of the onsite chemical storage tanks. Abengoa Bioenergy would transport and store process chemicals in vessels located in the biorefinery chemical storage areas (Roach 2009a, 2009aa).

The sulfuric acid would be delivered to the biorefinery by rail and would be stored in a 50,400-gallon (191-cubic meter), above-grade storage tank on the chemical storage pad. Sulfuric acid would be conveyed to process areas via an above-grade pipe rack.

The sodium hydroxide would be delivered to the biorefinery by truck and would be stored in a 10,000-gallon (40-cubic meter), above-grade storage tank in the pretreatment building. Sodium hydroxide would be conveyed to the following process areas via an above-grade pipe rack: biomass clean in place, biomass xylose filtrate, and biomass pre-saccharification mixer.

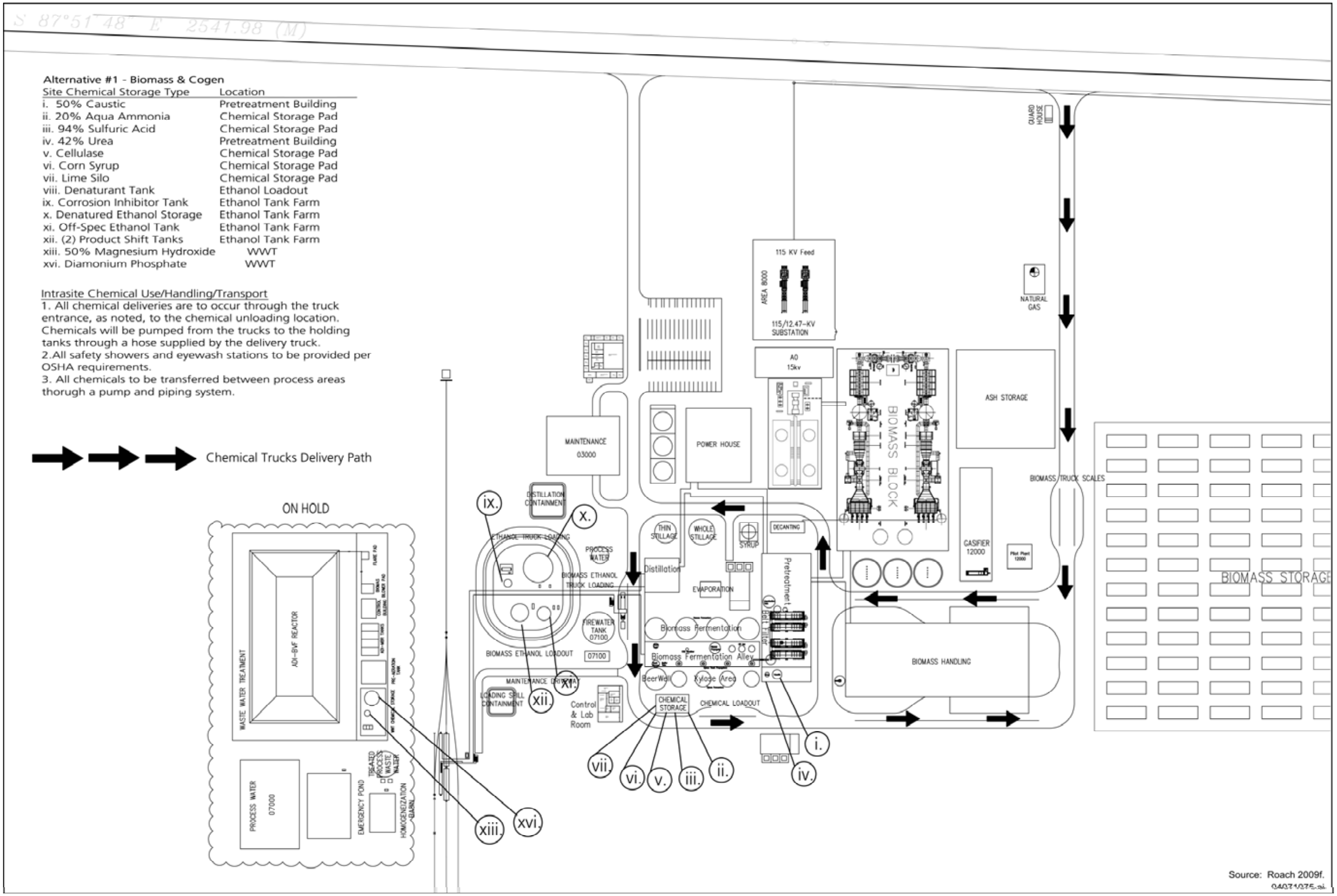


Figure 4-4. Locations of the onsite chemical storage tanks.

The aqueous ammonia would be delivered to the biorefinery by truck and would be stored in a 30,400-gallon (115-cubic meter), above-grade storage tank on the chemical storage pad. A day tank would also be located outdoors in the biomass fermentation area. Aqueous ammonia would be conveyed to process areas via an above-grade pipe rack.

The urea would be delivered to the biorefinery by truck and would be stored in a 13,300-gallon (50-cubic meter), above-grade storage tank in the pretreatment building. A day tank would also be located indoors in the biomass fermentation area. Urea would be conveyed to process areas via an above-grade pipe rack.

Additional process chemicals storage vessels on the chemical storage pad would include one 53,600-gallon (203-cubic meter) *cellulase* (enzyme cocktail) storage tank, one 53,000-gallon (200-cubic meter) corn syrup storage tank, one 3,000-cubic foot (85-cubic meter) limestone storage silo, and one 8,000-cubic foot (230-cubic meter) lime storage silo. One 1,000-gallon (3.8-cubic meter) magnesium hydroxide (50%) storage tank and one 500-gallon (1.9-cubic meter) diammonium phosphate storage tank would be located in the wastewater treatment facility area.

Additional chemical/hazardous materials storage tanks in the ethanol tank farm would include one 22,500-gallon (85-cubic meter) denaturant (gasoline) storage tank, one 460,000-gallon (1,740-cubic meter) denatured ethanol storage tank, two 60,000-gallon (230-cubic meter) shift tanks, and one 60,000-gallon off-specification tank. Abengoa Bioenergy would build each tank in the storage area onsite and would utilize the internal floating roof design. The storage tanks would be enclosed in a bermed area to retain spills that could occur. One 400-gallon (1.5-cubic meter) corrosion inhibitor storage tank and associated injection system would also be installed in the ethanol tank farm.

The chemical delivery system would be capable of unloading chemicals from tanker trucks and railcars. Abengoa Bioenergy would provide, as required, meters, filters, pumps, and loadout equipment for loadout into rail and truck tankers. The system would be capable of unloading sodium hydroxide, aqueous ammonia, urea, gasoline, *cellulose*, corn syrup, corrosion inhibitor, magnesium hydroxide, and diammonium phosphate from tanker trucks. The system would be capable of unloading sulfuric acid, limestone, and lime from railcars. All outdoor tanks and piping would have freeze protection. Enzyme use in the biomass area would be too small to store in bulk and convey by piping. Enzymes in the biomass area would be supplied in totes or drums.

DOE reviewed information pertaining to current hazardous materials management in Stevens County to analyze the impacts of the Proposed Action on current chemical users and suppliers in the region of influence. Chemical inventories could be impacted based on the types and amounts of chemicals required to operate the biorefinery. Stevens County Emergency Services indicated primary chemical use in the county is related to oil- and gasfield development (salt water and crude oil), agricultural lands and cooperatives (anhydrous ammonia, fertilizers, agricultural chemicals), and water treatment (chlorine). Stevens County Emergency Services identified no concentrated inventories of large amounts of chemicals in Stevens County (Schechter 2008). Based on the biorefinery chemical requirements and the availability of supplies, chemicals would be imported from suppliers outside the 50-mile (80-kilometer) region of influence. Table 4-22 lists major chemical suppliers for the biorefinery.

As these suppliers are located more than 50 miles (80 kilometers) from the Biorefinery Project site, DOE concludes that the chemical needs of the biorefinery would have no impact on chemical users or suppliers within the region of influence.

Table 4-22. Major chemical supplies for the biorefinery.

Chemical	Supplier	Point of origin
Sodium hydroxide	Oxy	Wichita, Kansas
Sulfuric acid	Kennecott	Salt Lake City, Utah
Lime, limestone	Mississippi Lime	Edwardsville, Kansas
Urea	Univar	Unknown
Aqueous ammonia	Univar	Unknown

Source: Roach 2009bb.

Table 4-23 lists the 2007 annual U.S. production quantities of the major chemicals used under the Proposed Action and the percentage of those quantities that would be used annually under the Proposed Action. The annual demand for these chemicals under the Proposed Action would be insignificant percentages of the annual U.S. production quantities.

Table 4-23. U.S. annual chemical production and percentage that would be used by the biorefinery.

Chemical by mass	Annual U.S. production [million metric tons (million short tons)]	Percent of total production used annually by the biorefinery
Sulfuric acid	37 (41)	0.009
Sodium hydroxide	8 (9)	0.016
Aqueous ammonia	11 (12)	0.056
Urea	6 (7)	0.008
Lime	20 (22)	0.031
Phosphoric acid	11 (12)	0.009

Source: ACS 2008.

The Biorefinery Project site is currently used for cattle grazing and crop production. The land consists of eight fields, ranging from 9 to 200 acres (0.04 to 0.81 square kilometers). The types of herbicides applied on various fields of the land include Roundup®, Bicep Lite II Mag®, 2,4-D, and 2,4-D amine. Pesticides applied on various fields of the land include Capture®. Fertilizers applied to the fields include anhydrous ammonia, granular phosphorus, and an urea/ammonium nitrate solution. Fungicide applications include Headline®. These agricultural chemicals are purchased locally (Roach 2008d). These chemical applications would cease on the biorefinery parcel at the start of and during construction of the biorefinery (Roach 2008d). Table 4-24 lists the approximate types and quantities of rodenticides and herbicides that would be used at the Project site during operations.

Table 4-24. Approximate types and quantities of rodenticides and herbicides that would be used during operations.

Chemical	Annual quantity
Rodenticides	
Fastrac All Weather Blox®	53 pounds (24 kilograms) (0.01% by weight)
Rozol Blue Tracking Powder®	22 pounds (10 kilograms) (0.2% by weight)
Herbicides	
Glyfos Pro Herbicides®	6 pounds (2.7 kilograms) (2% by weight)
Krovar®	14 pounds (6.4 kilograms) (7-10 pounds/acre)
Oust®	2.5 pounds (1.1 kilograms) (11/3-3 ounce/acre)
Rodeo®	60 gallons (230 liters (1.5% by weight)

Source: Roach 2009cc.

These chemicals can produce health hazards and adverse environmental impacts if not handled, stored, and applied properly and in accordance with manufacturer guidelines. Based on the relatively small quantities of these chemicals to be used, DOE does not anticipate adverse impacts resulting from the use of these chemicals at the Biorefinery Project site if the chemicals are handled, stored, and applied in accordance with the manufacturer guidelines and the chemical-specific material safety data sheets.

4.6.2 ACTION ALTERNATIVE

Under the Action Alternative, the biorefinery would process 440 tons (400 dry metric tons) per day of biomass through enzymatic hydrolysis to produce 12 million gallons (45 million liters) per year of denatured ethanol. The biorefinery would process 330 tons (300 dry metric tons) per day of biomass through *gasification* to produce syngas as fuel for steam production to power the biorefinery only. A small gas-fired boiler would be used to burn stillage cake and syrup residuals from distillation in the enzymatic hydrolysis process. This process would also produce steam to power the biorefinery. Under the Action Alternative, no energy would be exported to the regional power grid.

4.6.2.1 Construction Wastes

Under the Action Alternative, wastes requiring offsite disposal would be generated during the 18-month construction phase. Table 4-25 lists the anticipated construction wastes. The waste quantities listed in Table 4-25 are total projected wastes and do not include reductions due to recycling. The biorefinery construction and disposal facility operation schedules would be the same as those for the Proposed Action. The average estimated weight of construction wastes generated would be 70 tons (64 metric tons) per day. Further, the estimated solid waste generated due to the increase in worker population during the construction phase is 1 ton (0.9 metric ton) per day (Section 4.5.2.1.3).

Table 4-25. Construction wastes requiring offsite disposal under the Action Alternative.

Type of waste	Quantity/Volume
Ground excess, construction, and demolition debris	1,782,000 cubic feet, or 66,000 cubic yards (50,500 cubic meters) @950 pounds per cubic yard = 31,350 tons (28,440 metric tons)
Plastics, papers, and cartons	11,880 pounds, or 5.9 tons (5.4 metric tons)
Steel waste, pipes, and cables (trimmings and wastes)	118,800 pounds, or 59 tons (54 metric tons)
Metal cans (painting, chemical, and oil)	23,760 pounds, or 11.9 tons (10.8 metric tons)
Municipal solids (inorganic)	160,380 pounds, or 80.2 tons (72.8 metric tons)

Source: Roach 2009v.

Similar to the Action Alternative, DOE concludes the Stevens County landfill would not have adequate capacity to receive the construction wastes generated and maintain its small arid landfill exempt status. The non-recycled construction waste stream could be split among various permitted landfills and transfer stations within the region of influence, and the bulk of the construction and demolition waste could be received by the Grant County construction and demolition landfill. Splitting the construction waste among landfills would require permission from the selected facilities to receive the wastes.

4.6.2.2 Wastewater

The discussion on domestic sewage generated during construction and operations under the Action Alternative is presented in Section 4.5.2.1.

Under the Action Alternative, treatment of process wastewater in the onsite wastewater treatment facility would be the same as that for the Proposed Action. Under the Action Alternative, Abengoa Bioenergy would produce 160 gallons (600 liters) per minute (normal design flow) of wastewater that would be treated onsite and reused in the process. The system would be designed to treat an operating peak flow of 192 gallons (727 liters) per minute (Roach 2009dd). Treated wastewater would be recycled to the enzymatic hydrolysis process (Roach 2009dd).

Non-contact wastewater would be applied to the buffer area, as it would under the Proposed Action. However, under the Action Alternative, the biorefinery would generate 115 gallons (435 liters) per minute (normal design flow) of non-contact wastewater at the discharge Outfall. The system would be designed to handle an operating peak flow of 230 gallons (870 liters) per minute (Roach 2009dd). This would reduce the required capacity of the winter storage pond from 29,160,000 to 14,904,000 gallons (110,380 to 56,418 cubic meters) (Roach 2009j). Land application and temporary storage of wastewater would not result in runoff and, other than its temporary storage during months when land application was not feasible, would not result in ponding. The quality of the Outfall discharge would be similar to that characterized for the Proposed Action (Table 4-19) (Roach 2009w). DOE anticipates the land application of the Outfall discharge water would require a discharge permit in accordance with the Kansas Department of Health and Environment *Minimum Design Standards for Water Pollution Control Facilities* (KDHE 1978). Based on the hydrology analysis, the chemical composition of the wastewater, and the Kansas Department of Health and Environment permit conditions, DOE does not anticipate adverse impacts from the land application of the Outfall wastewater.

Under the Action Alternative, Abengoa Bioenergy would process 440 tons (400 dry metric tons) per day of biomass through enzymatic hydrolysis to produce ethanol. The options and associated wastewater impacts for handling lignin-rich stillage cake under the Action Alternative are the same as those for the Proposed Action (Section 4.6.1.2.3).

4.6.2.3 Wastes and Byproducts Management

Table 4-26 presents the projected wastes and byproducts under the Action Alternative. Dirt and fines resulting from biomass processing and municipal solid waste, including construction debris generated during the operations phase of the biorefinery, would be disposed of as waste at permitted facilities within 35 miles (56 kilometers) of the Biorefinery Project site. Based on an operating schedule of 350 days per year, there would be 25 tons (22.7 metric tons) per day of dirt and fines and 0.07 ton (0.064 metric ton) per day of municipal solid waste. Further, the estimated solid waste generated due to the increase in population during the operations phase is 0.3 ton (0.27 metric ton) per day (Section 4.5.2.1.3). The total solid waste stream from these sources equals 25.37 tons (23.02 metric tons) per day. Based on these observations, DOE concludes that there is not adequate capacity at the Stevens County landfill to receive the solid waste generated during the operations phase under the Action Alternative without modification of its small arid landfill exempt status. The operations phase solid waste stream could be split among various permitted landfills and transfer stations within the region of influence, in which case permission would be needed from the selected facilities to receive the waste.

Table 4-26. Waste and byproducts that would be produced under the Action Alternative.

Waste/Byproduct	Annual quantity	Treatment
Dirt and fines resulting from biomass processing	8,750 tons[a] (7,940 metric tons)	Permitted solid waste disposal facility
Municipal solid waste and construction debris	26 tons (24 metric tons)	Permitted solid waste disposal facility
Wastewater treatment facility sludge	5 – 7.5 gallons per minute (19 – 28.4 liters per minute)	Land-application – buffer area
Hazardous waste	1 ton (0.9 metric ton)	Hazardous waste treatment/disposal facility
Distiller's residual biomass solids (stillage cake)	45,000 dry tons (41,000 metric tons)	Feedstock for the biorefinery solid fuel boiler
Lignin	19,000 tons (17,000 metric tons)	Lignin-rich stillage cake extraction (option 1)
Genetically modified organisms	Included in stillage cake and syrup	Feedstock for the biorefinery solid fuel boiler
Solid biomass boiler ash	11,400 tons (10,300 metric tons)	Value-added nutrient replacement (option 1) Permitted solid waste disposal facility (option 2)
Gasification ash	8,500 tons (7,700 metric tons)	Value-added nutrient replacement (option 1) Permitted solid waste disposal facility (option 2)

Source: Roach 2009j.
a. Source: Roach 2009e.

Under the Action Alternative, the quantities, management methods, and impacts associated with the remaining wastes and byproducts listed in Table 4-26 are the same as those for the Proposed Action, as discussed in Section 4.6.1.3, except for the production of solid biomass boiler ash and gasification ash. A small gas-fired boiler would be used to burn stillage cake and syrup residuals from distillation in the enzymatic hydrolysis process. This process would produce steam to power the biorefinery only. Unlike the Proposed Action, raw biomass would not be burned in the solid biomass boiler. Therefore, a smaller amount of ash would be produced from the solid biomass boiler. However, the Action Alternative includes a gasifier and would produce gasification ash, whereas the Proposed Action does not.

Similar to the Proposed Action, there would be two options for managing solid biomass boiler and gasifier ash (Section 4.6.1.3.1 – Option 1 and Section 4.6.1.3.2 – Option 2). Under the Action Alternative, the combined solid biomass boiler and gasifier ash produced would be 19,900 tons (18,100 metric tons) per year. If lignin was not extracted from the lignin-rich stillage cake before burning in the boiler, approximately 5,600 additional tons (5,100 metric tons) per year of ash would be generated by the boiler. This ash could be sold to biomass producers as a lower-cost, value-added nutrient replacement co-product (Option 1). If the nutrient replacement ash was sold, it would not require disposal as solid waste in a permitted solid waste disposal facility. If none of the ash was sold, from 19,900 to 25,500 additional tons (18,100 to 23,100 metric tons) per year [or 57 to 73 tons (52 to 66 metric tons) per day, based on a 350-day operating schedule] of solid waste would be produced, requiring disposal at a permitted solid waste disposal facility (Option 2). While less than the Proposed Action, this quantity of waste would exceed the capacity of the Stevens County landfill without a permit modification. This waste stream could be split among various permitted landfills and transfer stations within the region of influence, in which case permission would be needed from the selected facilities to receive the waste.

4.6.2.4 Hazardous Materials Management

Table 4-27 presents the types and amounts of chemicals that would be required under the Action Alternative. While the quantities and storage vessel capacities vary, the management methods, suppliers, and impacts associated with hazardous materials use under the Action Alternative are the same as those for the Proposed Action (Section 4.6.1.4).

Table 4-27. Chemicals required during operations under the Action Alternative.

Chemical	Annual quantity
Sulfuric acid (94%)	5,708 tons (5,178 metric tons)
Sodium hydroxide caustic (50%)	475 tons (431 metric tons)
Aqueous ammonia (20%)	1,852 tons (1,680 metric tons)
Urea (42%)	88 tons (80 metric tons)
Cellulase	7,581 tons (6,877 metric tons)
Corn syrup	525 tons (476 metric tons)
Lime ($Ca(OH)_2$)	3,906 tons (3,543 metric tons)
Corrosion inhibitor (DCI-11®)	35 gallons (130 liters) per year
Magnesium hydroxide (50%)	97 tons (88 metric tons)
Diammonium phosphate	11 tons (10 metric tons)
Gasoline (ethanol denaturant)	563,500 gallons (2,133 cubic meters) per year

Source: Roach 2009j.

4.6.3 SUMMARY OF WASTES, BYPRODUCTS, AND HAZARDOUS MATERIALS IMPACTS

The Stevens County landfill would not have adequate capacity to receive the construction phase or operations phase wastes generated under the Proposed Action or Action Alternative and maintain its small arid landfill exempt status. The non-recycled construction waste streams could be split among various permitted landfills and transfer stations within the region of influence, and the bulk of the construction and demolition waste could be received by the Grant County construction and demolition landfill. Splitting the construction waste among landfills would require permission from the selected facilities to receive the wastes. Loss of land used for landfills would be an irreversible and irretrievable loss of resources. However, there is adequate capacity within the region of influence to receive the construction and operations wastes of the Proposed Action or Action Alternative. To mitigate impacts to disposal facilities within the region of influence, the development of a waste management and pollution prevention plan should be considered prior to contracting the biorefinery construction. Abengoa Bioenergy should identify landfills for the disposal of solid waste and industrial wastes generated during construction and operation of the biorefinery. Construction specifications should direct contractors where to recycle and/or dispose of construction-generated wastes.

Under the Proposed Action and Action Alternative, the onsite wastewater treatment facility at the biorefinery would treat all process wastewater generated onsite and would not discharge any to the Hugoton wastewater system. Wastewater treated onsite would be reused in the ethanol production process. Wastewater that would not be recycled and reused in the production process or treated in the onsite wastewater treatment system would be discharged from a combined discharge Outfall. Abengoa

Bioenergy would use a land application process to treat the wastewater from the Outfall. This water would be used to irrigate biomass crops on the buffer area of the Biorefinery Project site. Wastewater treatment facility sludge would also be applied on the buffer area. Based on hydrology analysis, the chemical composition of the wastewater and sludge, and the requirements of the Kansas Department of Health and Environment *Minimum Design Standards for Water Pollution Control Facilities* (KDHE 1978), DOE does not anticipate adverse impacts from the land application of the Outfall wastewater or sludge.

Extraction of lignin from stillage cake would result in the generation of additional wastewater treatment and reuse in the production process. The water balance and wastewater treatment facility design would require modification if the lignin extraction option was exercised. If lignin was not extracted from the stillage, additional wastewater requiring treatment would not be generated.

Under the Proposed Action and Action Alternative, DOE does not anticipate adverse impacts from the handling and disposal of hazardous wastes generated at the biorefinery if Abengoa Bioenergy's proposed hazardous waste management practices are implemented.

Genetically modified organisms used in the enzymatic hydrolysis process under the Proposed Action and Action Alternative would be killed by a heat sterilization process and would be contained in the beer column bottoms. The bottoms stream would be dewatered and the residual solids sent to the solid biomass boiler for burning.

The solid biomass boiler (Proposed Action and Action Alternative) and the gasifier (Action Alternative only) would generate ash. Abengoa Bioenergy would market and sell the ash byproduct to biomass producers as a lower-cost, value-added nutrient replacement co-product. If the nutrient replacement ash was sold, it would not require disposal as a solid waste in a permitted solid waste disposal facility. If the solid boiler and gasifier ash was not sold as a nutrient replacement byproduct, it would require disposal at a permitted solid waste disposal facility. Stevens County landfill would not have adequate capacity to receive this quantity of ash without a permit modification. This waste stream could be split among permitted landfills and transfer stations within the region of influence, but this would require permission from the selected facilities to receive the waste.

Based on the biorefinery chemical requirements under the Proposed Action and Action Alternative and the availability of supplies, chemicals would be imported from suppliers outside the 50-mile (80-kilometer) region of influence. Because these suppliers would be farther than 50 miles from the biorefinery, DOE concludes the chemical needs of the biorefinery would have no impact on chemical users or suppliers within the region of influence. In addition, the annual demand for chemicals by the action alternatives would be insignificant percentages of annual U.S. production quantities.

DOE does not anticipate adverse impacts resulting from the use of herbicides and rodenticides at the biorefinery under the Proposed Action and Action Alternative if the chemicals were handled, stored, and applied in accordance with manufacturer guidelines and the chemical-specific material safety data sheets.

4.7 Transportation

This section describes the potential transportation-related impacts associated with the Proposed Action and Action Alternative. Section 4.7.1 describes the impacts of the Proposed Action and Section 4.7.2 describes the impacts of the Action Alternative.

4.7.1 PROPOSED ACTION

4.7.1.1 Car and Truck Traffic

A traffic impact analysis prepared for Abengoa Bioenergy (TranSystems 2008) describes the traffic conditions near the Biorefinery Project site using *level of service*. Level of service is a qualitative measure describing operational conditions within a traffic stream based on service measures such as speed and travel time, freedom to maneuver, traffic interruptions, comfort, and convenience (TRB 2000). Level of service is rated from A to F: Service level A represents the most desirable condition with free-flow movement of traffic and minimal delays. Service level F generally indicates severely congested conditions with excessive delays to motorists. Intermediate grades of B, C, D, and E reflect incremental increases in the average delay per stopped vehicle. Delay is measured in seconds per vehicle. Table 3-17 in Chapter 3 of this Abengoa Biorefinery Project EIS shows the upper limit of delay associated with each level of service for signalized and unsignalized intersections (TranSystems 2008).

In addition to level of service, the traffic impact analysis evaluated the ratio of volume to capacity to assess the overall capacity of the intersection or unsignalized movement. The ratio of volume to capacity reflects, regardless of delay, the ability to accommodate the existing or projected traffic volumes over the course of a peak hour. A volume-to-capacity ratio of 1.00 means that an intersection or road is operating at 100 percent of its capacity (TranSystems 2008).

The level of service rating deemed acceptable varies by community, type of road or intersection, and traffic control device. In communities similar to Hugoton, Kansas, service level C for signalized intersections is acceptable. However, at unsignalized intersections, service levels D, E, and F are accepted for low to moderate traffic volumes where the installation of a traffic signal is not warranted by the conditions at the intersection, or the location has been deemed undesirable for signalization for other reasons (TranSystems 2008).

The traffic impact analysis looked at anticipated traffic from the Biorefinery Project site and the existing traffic at 11 intersections near the Project site for the peak hours during mornings and afternoons. The evaluation was conducted for two time periods: (1) at the beginning of biorefinery operations, and (2) after 20 years of operations to account for future population growth in the area. The traffic study was based on 1,078 employee trips and truck shipments per day. For the Proposed Action, there would be fewer than 700 employee trips and truck shipments per day during the construction or operations phases, and the results of the traffic study would tend to overestimate potential transportation impacts.

Tables 4-28 and 4-29 summarize the level of service, delay times, volume-to-capacity ratios, and overall capacity utilization for each intersection at the beginning of operations at the Biorefinery Project site for the Proposed Action. All intersections are predicted to perform at service level A or B, which indicates minimal delays. At one intersection, the westbound lane of US-56/K-25/Main Street and First Street/Road P, the level of service is predicted to increase from A to B. The maximum volume-to-

Table 4-28. Level of service, delay times, and volume-to-capacity ratios at intersections near the Project site at the beginning of biorefinery operations under the Proposed Action.

Intersection	Morning peak hour			Afternoon peak hour		
	Level of service	Delay (seconds)	Volume-to-capacity ratio	Level of service	Delay (seconds)	Volume-to-capacity ratio
US-56/K-25/K-51 and Road 10						
Eastbound left	A	0.0	0.00	A	0.1	0.00
Westbound left	A	0.2	0.00	A	0.4	0.00
Northbound	A	8.8	0.00	A	0.0	0.00
Southbound	A	10.0	0.01	A	8.6	0.00
US-56/K-25/K-51 and Road 11						
Eastbound left	A	4.0	0.03	A	1.8	0.01
Westbound left	A	0.2	0.00	A	0.2	0.00
Northbound	A	8.5	0.00	B	10.5	0.00
Southbound	A	9.8	0.05	B	10.0	0.08
US-56/K-25/K-51 and Road 12						
Eastbound left	A	1.6	0.01	A	0.9	0.01
Westbound left	A	2.5	0.02	A	2.8	0.02
Northbound	A	9.2	0.03	A	9.9	0.05
Southbound	B	10.4	0.08	B	10.9	0.06
US-56/K-25/Main Street and K-51						
Eastbound	A	9.0	--	A	9.7	--
Westbound	A	9.0	--	A	9.0	--
Northbound	A	8.3	--	A	8.5	--
Southbound	A	9.0	--	A	9.3	--
US-56/K-25/Main Street and First Street/Road P						
Eastbound	B	10.3	0.08	B	10.2	0.07
Westbound	B[a]	10.2	0.06	B	10.6	0.07
Northbound left	A	2.2	0.01	A	1.4	0.01
Southbound left	A	1.0	0.00	A	0.4	0.00
US-56 and K-25/Road 13						
Northbound	B	10.8	0.08	B	10.5	0.08
Southbound	B	11.5	0.23	B	11.5	0.22
Northeast-bound left	A	3.1	0.04	A	2.4	0.03
Southwest-bound left	A	2.1	0.01	A	2.1	0.01
Road P and Road 10						
Eastbound	A	0.3	0.00	A	0.0	0.00
Westbound	A	0.0	0.00	A	0.0	0.00
Northbound	A	9.1	0.00	A	8.6	0.00
Southbound	A	8.7	0.00	A	8.8	0.00
Road P and Road 11						
Eastbound	A	9.2	0.03	A	9.2	0.03
Westbound	A	9.6	0.05	A	9.4	0.03
Northbound	A	1.4	0.01	A	1.1	0.01
Southbound	A	0.0	0.00	A	0.0	0.00
Road P and Road 12						
Eastbound	A	0.3	0.00	A	0.2	0.00
Westbound	A	0.0	0.02	A	0.08	0.00
Northbound	A	9.4	0.01	A	9.0	0.01
Southbound	A	9.0	0.02	A	9.0	0.03

Table 4-28. Level of service, delay times, and volume-to-capacity ratios at intersections near the Project site at the beginning of biorefinery operations under the Proposed Action (continued).

	Morning peak hour			Afternoon peak hour		
Intersection	Level of service	Delay (seconds)	Volume-to-capacity ratio	Level of service	Delay (seconds)	Volume-to-capacity ratio
K-25 and Road Q						
Eastbound	A	9.6	0.03	B	10.4	0.03
Northbound left	A	2.0	0.02	A	0.7	0.01
Abengoa biorefinery entrance and Road 11						
Eastbound left	B	10.6	0.05	A	9.5	0.05
Eastbound light	A	9.3	0.03	A	9.0	0.03
Northbound left	A	6.5	0.04	A	2.6	0.01

Source: TranSystems 2008.
a. Level of service increased from A to B.

Table 4-29. Capacity utilization of intersections near the Project site at the beginning of biorefinery operations under the Proposed Action.

Intersection	Morning peak hour capacity utilization (percent)	Afternoon peak hour capacity utilization (percent)
US-56/K-25/K-51 and Road 10	13.3	13.8
US-56/K-25/K-51 and Road 11	25.6	23.7
US-56/K-25/K-51 and Road 12	24.3	25.5
US-56/K-25/Main Street and K-51	35.5	36.2
US-56/K-25/Main Street and First Street/Road P	17.8	18.1
US-56 and K-25/Road 13	36.2	34.8
Road P and Road 10	13.3	13.3
Road P and Road 11	24.6	22.6
Road P and Road 12	20.0	20.0
K-25 and Road Q	27.0	17.6
Abengoa biorefinery Entrance and Road 11	20.0	17.0

Source: TranSystems 2008.

capacity ratio for the 11 intersections would be 0.23 for the southbound lane of the intersection of US-56 and K-25/Road 13, which indicates that this lane would operate at 23 percent of its capacity. Overall, this intersection would utilize about 36 percent of its capacity. The intersection of US-56/K-25/Main Street and K-51 would also utilize about 36 percent of its capacity.

Tables 4-30 and 4-31 summarize the level of service, delay times, volume-to-capacity ratios, and overall capacity utilization for each intersection after 20 years of biorefinery operations under the Proposed Action. The traffic impact analysis estimated that there would be no growth for some of the intersections, some negative growth for other intersections, and large amounts of growth for other intersections. Again, all intersections are predicted to perform at service level A or B, which indicates minimal delays, except for the southbound lane of the intersection of US-56 and K-25/Road 13, which is predicted to operate at service level C during peak morning hours and which operated at level of service B at the start of operations. At several other intersections, the level of service is predicted to increase from A to B. These intersections are noted in Table 4-30. As mentioned previously, at unsignalized intersections, service levels D, E, and F are often accepted for low to moderate traffic volumes. The volume-to-capacity ratio for this intersection would be 0.37, which indicates that this lane would operate at 37 percent of its capacity. Overall, this intersection would utilize about 45 percent of its capacity. The maximum overall capacity utilization for the 11 intersections would be for the intersection of US-56/K-25/Main Street and K-51, which would utilize about 46 percent of its capacity. Based on the traffic impact analysis, no roadway improvements were identified as necessary to help truck and employee traffic access the biorefinery.

Table 4-30. Level of service, delay times, and volume-to-capacity ratios at intersections near the Project site for future conditions under the Proposed Action.

Intersection	Morning peak hour			Afternoon peak hour		
	Level of service	Delay (seconds)	Volume-to-capacity ratio	Level of service	Delay (seconds)	Volume-to-capacity ratio
US-56/K-25/K-51 and Road 10						
Eastbound left	A	0.0	0.00	A	0.1	0.00
Westbound left	A	0.1	0.00	A	0.4	0.00
Northbound	A	8.9	0.01	A	0.0	0.00
Southbound	B[a]	10.5	0.01	A	8.7	0.00
US-56/K-25/K-51 and Road 11						
Eastbound left	A	3.5	0.03	A	1.7	0.01
Westbound left	A	0.1	0.00	A	0.2	0.00
Northbound	A	8.6	0.00	B	11.4	0.00
Southbound	B[a]	10.9	0.08	B[a]	10.9	0.12
US-56/K-25/K-51 and Road 12						
Eastbound left	A	1.6	0.01	A	0.8	0.01
Westbound left	A	2.8	0.03	A	3.0	0.03
Northbound	A	9.7	0.05	B[a]	10.9	0.08
Southbound	B	11.9	0.13	B	12.8	0.11
US-56/K-25/Main Street and K-51						
Eastbound	B[a]	11.4	--	B[a]	13.6	--
Westbound	B[a]	11.8	--	B[a]	12.2	--
Northbound	A	9.8	--	B[a]	10.2	--
Southbound	B[a]	11.7	--	B[a]	12.2	--
US-56/K-25/Main Street and First Street/Road P						
Eastbound	B	11.3	0.13	B	11.4	0.15
Westbound	B[a]	11.0	0.09	B	12.1	0.13
Northbound left	A	1.9	0.01	A	1.5	0.01
Southbound left	A	1.0	0.01	A	0.4	0.00
US-56 and K-25/Road 13						
Northbound	B	12.4	0.14	B	11.9	0.14
Southbound	C[b]	15.1	0.37	B	14.2	0.37
Northeast bound left	A	3.2	0.06	A	2.5	0.04
Southwest bound left	A	2.2	0.02	A	2.2	0.02
Road P and Road 10						
Eastbound	A	0.2	0.00	A	0.0	0.00
Westbound	A	0.0	0.00	A	0.0	0.00
Northbound	A	9.2	0.00	A	8.7	0.00
Southbound	A	8.7	0.00	A	8.9	0.00
Road P and Road 11						
Eastbound	A	9.3	0.04	A	9.4	0.05
Westbound	A	9.8	0.06	A	9.5	0.04
Northbound	A	1.7	0.01	A	1.2	0.01
Southbound	A	0.0	0.00	A	0.0	0.00

Table 4-30. Level of service, delay times, and volume-to-capacity ratios at intersections near the Project site for future conditions under the Proposed Action (continued).

Intersection	Morning peak hour Level of service	Morning peak hour Delay (seconds)	Morning peak hour Volume-to-capacity ratio	Afternoon peak hour Level of service	Afternoon peak hour Delay (seconds)	Afternoon peak hour Volume-to-capacity ratio
Road P and Road 12						
Eastbound	A	0.2	0.00	A	0.1	0.00
Westbound	A	0.0	0.02	A	0.6	0.00
Northbound	A	9.4	0.01	A	9.0	0.01
Southbound	A	9.1	0.03	A	9.2	0.04
K-25 and Road Q						
Eastbound	B	10.1	0.03	B	11.0	0.04
Northbound left	A	1.5	0.02	A	0.5	0.01
Abengoa biorefinery entrance and Road 11						
Eastbound Left	B	10.7	0.05	A	9.7	0.05
Eastbound Right	A	9.3	0.03	A	9.2	0.04
Northbound Left	A	6.0	0.04	A	1.9	0.01

Source: TranSystems 2008.

a. Level of service increased from A to B.

b. Level of service increased from B to C.

Table 4-31. Capacity utilization of intersections near the Project site for future conditions under the Proposed Action.

Intersection	Morning peak hour capacity utilization (percent)	Afternoon peak hour capacity utilization (percent)
US-56/K-25/K-51 and Road 10	14.1	15.4
US-56/K-25/K-51 and Road 11	27.7	29.0
US-56/K-25/K-51 and Road 12	30.8	32.8
US-56/K-25/Main Street and K-51	45.9	45.5
US-56/K-25/Main Street and First Street/Road P	22.8	25.2
US-56 and K-25/Road 13	44.6	43.8
Road P and Road 10	13.3	13.3
Road P and Road 11	25.4	25.1
Road P and Road 12	20.0	20.5
K-25 and Road Q	32.0	20.3
Abengoa biorefinery entrance and Road 11	20.3	17.3

Source: TranSystems 2008.

Road Damage

The increased truck traffic associated with the Proposed Action would result in increased pavement deterioration. This pavement deterioration would result from the weight of vehicles being applied to a pavement surface and is dependent on truck characteristics, pavement characteristics, and environmental factors. In the report *Impact of Kansas Grain Transportation on Kansas Highway Damage Costs*, (Babcock and Bunch 2002), the costs associated with increased pavement deterioration from increased grain shipments by truck as a result of hypothetical shortline railroad abandonments were evaluated. These costs were estimated to be $0.17 per truck-mile ($0.11 per truck-kilometer). If it was assumed that biomass shipments would be made in a manner similar to these grain shipments, the annual cost of the pavement damage caused by the additional truck shipments of biomass would be about $680,000. The shipping of other materials, such as chemicals and waste, would also result in pavement damage. Quantitative estimates of the pavement damage caused by shipments of these other materials have not been made because the transportation system used for these materials would not be similar to the transportation system discussed in the above report (Babcock and Bunch 2002) for grain shipments. However, estimating the highway pavement damage costs attributed to truck (for example, tractor-trailers) traffic is the subject of research efforts being conducted at the Mid-American Transportation Center.

4.7.1.2 Rail Traffic

A 0.5-mile (0.8-kilometer)-long railroad spur would be built on the Biorefinery Project site to tie the biorefinery to the Cimarron Valley Railroad to accommodate receipt of materials and shipment of products and wastes (Chapter 2, Section 2.1.2.4.6). From 2003 to 2007, there was an average of 35,000 train-miles (56,000 train-kilometers) per year of rail traffic on the Cimarron Valley Railroad (FRA 2008). Based on an average haul length of 59 miles (95 kilometers) (Babcock and Sanderson 2006), this would be equivalent to about 600 trains per year, or about 2 trains per day. As a result of operations at the Biorefinery Project site, it is estimated that there would be an additional 1,108 carloads per year of denatured ethanol and waste shipped from the Project site and an additional 195 carloads per year of chemicals shipped to the Project site. Based on an average train length of 26 cars (Babcock and Sanderson 2006), this is equivalent to about 43 additional trains per year carrying denatured ethanol and waste and about 8 additional trains per year carrying chemicals, or a total of 51 additional trains per year. This is about 5 additional trains every month. The Cimarron Valley Railroad could also increase the length of existing trains, which would result in fewer additional trains. The capacity of a single-track rail line is generally in the range of 40 to 60 trains per day. Therefore, the additional rail traffic from the Project site would not adversely affect the operations of the Cimarron Valley Railroad.

4.7.1.3 Traffic Fatalities

This section presents the estimated number of highway-related and rail-related traffic fatalities near the Biorefinery Project site as a result of the increased truck and rail traffic associated with the Proposed Action. Impacts associated with fatalities are discussed in terms of the construction phase and the operations phase. Commuting worker traffic fatalities are reported separately from fatalities associated with the shipment of biomass, chemicals, denatured ethanol product, and waste. Potential impacts resulting from material releases, fires, and explosions that might result from intersite transportation accidents are discussed in this section to put the potential impacts from these accidents into perspective. Accidents related to intrasite transport of chemicals, denatured ethanol product, and waste are discussed in Section 4.12 of this EIS.

4.7.1.3.1 *Construction Phase*

Construction Materials

During construction of the biorefinery, materials such as steel, concrete, piping, cabling, railroad tracks, and sub-ballast would be shipped to the site. Table 4-32 lists the quantities of these materials and the associated number of shipments that would be required to ship these materials to the Biorefinery Project site using trucks under the Proposed Action.

It is likely that some of these construction materials could be obtained locally, in cities such as Dodge City or Liberal, Kansas. However, Dodge City and Liberal have populations of about 25,000 people, and it is likely that not all construction materials could be obtained in these cities. In contrast, Wichita, Kansas, has a population of more than 350,000 people and, consequently, it is more likely that all construction materials would be obtained from Wichita. In addition, because Wichita is farther from Hugoton than are Dodge City or Liberal (see Table 3-15 in Chapter 3), shipments from Wichita to Hugoton would result in slightly higher transportation impacts than shipments from Dodge City or Liberal. Therefore, for bounding purposes, this analysis assumes all construction material shipments originate in Wichita. Construction and demolition wastes were assumed to be disposed of at a landfill within 30 miles (48 kilometers) of the Biorefinery Project site.

Table 4-32. Construction material and waste quantities and shipments under the Proposed Action.

Material	Quantity	Number of truck shipments
Steel	4,900 tons (4,400 metric tons)	445
Concrete	50,000 cubic yards (38,000 cubic meters)	3,823
Fill material	225,000 cubic yards (172,000 cubic meters)	17,203
Asphalt paving	38,000 square feet (3,500 square meters)	108
Storm sewer pipe	2,000 linear feet (610 linear meters)	7
Internal and external water pipe	35,000 linear feet (11,000 linear meters)	11
Railroad tracks	9,000 linear feet (2,700 linear meters)	17
Rock sub-ballast	6,000 cubic yards (4,600 cubic meters)	459
Mechanical process piping	51,000 linear feet (16,000 linear meters)	16
Electrical and control cables	166,000 linear feet (50,600 linear meters)	51
Cable trays	13,000 linear feet (4,000 linear meters)	4
Fencing	20,000 linear feet (6,100 linear meters)	7
Gravel	56,000 cubic yards (43,000 cubic meters)	4,282
Firewater piping	6,000 linear feet (1,800 linear meters)	2
Construction and demolition wastes	70,000 tons (64,000 metric tons)	5,640
Total		32,075

Source: Roach 2009j.

The construction phase would last approximately 18 months. During this phase, construction materials and wastes would be shipped about 13 million round-trip miles (21 million round-trip kilometers). Based on a Kansas statewide large truck fatality rate of 11.9 traffic fatalities per 100 million truck-miles (7.39 per 100 million truck-kilometers) traveled, there would be an estimated 1.5 traffic fatalities from the shipment of these construction materials. For perspective, over the same time period of 18 months, there would an estimated 670 traffic fatalities in Kansas and 41 traffic fatalities in the nine counties surrounding the Project site.

Commuting Workers

During the construction phase, a peak of 250 workers would commute back and forth to the Biorefinery Project site and a total of 10,877 worker-weeks would be required for construction (Roach 2009j). While some workers could choose to live in Hugoton, other workers could choose to live in the other cities surrounding the Project site, such as Liberal, Sublette, Ulysses, Johnson City, Elkhart, Kansas, or

Guymon, Oklahoma. Based on the distances presented in Chapter 3, Table 3-15, it is likely that the workers would commute from a distance of 50 miles (80 kilometers) or less.

The construction phase would last approximately 18 months. During this phase, commuting workers would travel about 5.7 million round-trip miles (9.2 million round-trip kilometers). Based on a Kansas statewide fatality rate of 1.5 traffic fatalities per 100 million vehicle-miles (0.93 per 100 million vehicle-kilometers) traveled, there would be an estimated 0.086 traffic fatality for commuting workers during the construction phase. For perspective, over the same time period of 18 months, there would an estimated 670 traffic fatalities in Kansas and 41 traffic fatalities in the nine counties surrounding the Project site.

4.7.1.3.2 *Operations Phase*

Materials Used or Produced During Operations

During the operations phase, materials, such as biomass, chemicals, denatured ethanol product, and wastes, would be shipped to or from the Biorefinery Project site. Table 4-33 lists the quantities of these materials and the associated annual number of shipments that would be required to ship these materials to the Project site under the Proposed Action.

Table 4-33. Materials that would be used or produced during the operations phase under the Proposed Action.

Material	Annual quantity	Number of shipments (per year)[a]
Biomass	1,029,429 tons (wet) [933,877 metric tons (wet)]	88,236
Chemicals		
Sodium hydroxide	2,860,032 pounds (1,297,282 kilograms)	58
Aqueous ammonia	13,353,984 pounds (6,057,234 kilograms)	270
Sulfuric acid	7,084,224 pounds (3,213,333 kilograms)	38[b]
Urea	570 tons (520 metric tons)	24
Gasoline (denaturant)	882,000 gallons (3,339,000 liters)	104
Cellulase	14,836 tons (13,460 metric tons)	600
Corn syrup	12,690 tons (11,500 metric tons)	513
Lime	6,723 tons (6,099 metric tons)	75[b]
Limestone	7,362 tons (6,679 metric tons)	82[b]
Corrosion inhibitor	47 gallons (180 liters)	4
Magnesium hydroxide	245,000 pounds (111,000 kilograms)	5
Diammonium phosphate	10,500 pounds (4,800 kilograms)	1
Herbicides, pesticides, rodenticides, other chemicals	100 pounds (50 kilograms)	4
Diesel fuel	1,786,944 gallons (6,764,173 liters)	239
Fluidized bed sand	700 tons (640 metric tons)	64
Denatured ethanol product	18 million gallons (68 million liters)	632[b]
Waste		
Dirt and fines	33,600 tons (30,500 metric tons)	3,049
Lignin	44,079 tons (39,990 metric tons)	476[b]
Boiler ash	79,671 tons (72,276 metric tons)	7,228
Hazardous waste	1 ton (0.9 metric tons)	4
Municipal solid waste	33 tons (30 metric tons)	4
Total		101,710

Source: Roach 2009j.

a. All shipments made using trucks except where noted.

b. Shipments made using rail.

The operations phase is expected to continue for 30 years. During this phase, the materials listed in Table 4-33 would be shipped about 250 million round-trip miles (400 million round-trip kilometers). Based on a Kansas statewide large truck fatality rate of 11.9 traffic fatalities per 100 million truck-miles (7.39 per 100 million truck-kilometers) traveled and a national railroad fatality rate of 12.6 fatalities per 100 million railcar-miles (7.83 per 100 million railcar-kilometers) traveled, there would be an estimated 30 traffic fatalities from the shipment of these materials. For perspective, over the same period of 30 years, there would be an estimated 13,400 traffic fatalities in Kansas and 820 traffic fatalities in the nine counties surrounding the Project site.

Commuting Workers

During the operations phase, 43 workers would commute back and forth to the Biorefinery Project site. As with construction workers, some workers could choose to live in Hugoton, other workers could choose to live in the other cities surrounding the Project site, such as Liberal, Sublette, Ulysses, Johnson City, Elkhart, Kansas, or Guymon, Oklahoma. Based on the distances presented in Chapter 3, Table 3-15, it is likely that the workers would commute from a distance of 50 miles (80 kilometers) or less.

The operations phase is expected to continue for 30 years. During this period, commuting workers would travel about 34 million round-trip miles (55 million round-trip kilometers). Based on a Kansas statewide fatality rate of 1.5 traffic fatalities per 100 million vehicle-miles (0.93 per 100 million vehicle-kilometers) traveled, there would be an estimated 0.50 traffic fatality for commuting workers during the operations phase. For perspective, over the same period of 30 years, there would an estimated 13,400 traffic fatalities in Kansas and 820 traffic fatalities in the nine counties surrounding the Biorefinery Project site.

4.7.1.4 Hazardous Materials Transportation Accidents

Hazardous materials that would be shipped to or from the Biorefinery Project site in the largest quantities would be gasoline, denatured ethanol (containing 95-percent ethanol and 5-percent gasoline), aqueous ammonia, sulfuric acid, and sodium hydroxide. The U.S. Department of Transportation regulations that cover the transportation of these hazardous materials are contained in 49 CFR Parts 171 through 180.

These regulations cover the following areas:

- Hazardous materials classification (49 CFR Parts 171 and 173)
- Hazard communication (49 CFR Parts 172, Subparts A through G)
- Packaging requirements (49 CFR Parts 173, 178, 179, and 180)
- Operational rules (49 CFR Parts 171, 173, 174, 175, 176, and 177)
- Training and security (49 CFR Part 172, Subparts H and I)
- Registration (49 CFR Part 171)

Training of hazardous materials workers must include general awareness and familiarization training, job-specific training, safety training, security training, and driver training. Driver training must include pre-trip safety inspections; use of vehicle controls and equipment including operation of emergency equipment; operation of the vehicle; procedures for maneuvering tunnels, bridges, and railroad crossings; requirements pertaining to attendance of vehicles, parking, smoking, routing, and incident reporting; and loading and unloading of the hazardous materials. Specialized training regarding the operation of cargo tanks holding hazardous materials is also required. In addition, companies that transport hazardous materials must maintain a minimum of $5 million of insurance, which could be used to pay for the cleanup of a spill.

Transportation accidents involving the hazardous materials that would be shipped to the Biorefinery Project site could involve spills, fires, or explosions. This rest of this section summarizes the potential hazards associated with these hazardous materials and provides information on isolation areas and evacuation zones should a transportation accident involving these hazardous materials occur. The following is excerpted from the U.S. Department of Transportation *2008 Emergency Response Guidebook* (DOT n.d.)

The potential hazards associated with gasoline and denatured ethanol are fire and explosion. Gasoline and denatured ethanol are highly flammable and can be easily ignited by heat, sparks, or flames. Gasoline and denatured ethanol vapors could form explosive mixtures with air, and vapors may travel to a source of ignition and flash back. Gasoline and denatured ethanol vapors are heavier than air and could spread along the ground and collect in low or confined areas, such as sewers or basements. Gasoline and denatured ethanol containers could also explode when heated.

Inhalation of gasoline or denatured ethanol vapors or contact with liquid gasoline or denatured ethanol could irritate or burn the skin and eyes. Gasoline or denatured ethanol fires could produce irritating, corrosive, or toxic gases and gasoline, or denatured ethanol vapors could cause dizziness or suffocation. Runoff from fire control could cause pollution.

Fires involving ethanol/gasoline mixtures containing more than 10-percent ethanol should be treated differently than traditional gasoline fires because these mixtures are polar/water-miscible flammable liquids (they mix readily with water) and degrade the effectiveness of non alcohol-resistant fire-fighting foam. Denatured ethanol fires can only be extinguished using alcohol-resistant type foams, such as alcohol-resistant, aqueous film-forming foam or alcohol-resistant, film-forming fluoroprotein foam. All other types of foams or water additives are ineffective because the foam blanket is destroyed when it strikes the fuel surface. Gasoline fires may be extinguished using conventional aqueous film-forming foam.

As an immediate precautionary measure, a spill or leak involving gasoline or denatured ethanol should be isolated for a distance of at least 50 meters (150 feet) in all directions. In the event of a large spill involving gasoline or denatured ethanol, an initial downwind evacuation zone of at least 300 meters (1,000 feet) should be considered. If a rail or truck tank car containing gasoline or denatured ethanol is involved in a fire, the area out to 800 meters (0.5 mile) in all directions should be isolated, and evacuation out to 800 meters (0.5 mile) should be considered.

Aqueous ammonia could be toxic if inhaled, ingested, or absorbed through the skin. As an immediate precautionary measure, a spill or leak involving aqueous ammonia should be isolated for a distance of at least 50 meters (150 feet) in all directions. If a rail or truck tank car containing aqueous ammonia is involved in a fire, the area out to 800 meters (0.5 mile) in all directions should be isolated, and evacuation out to 800 meters (0.5 mile) should be considered.

The potential hazard associated with sulfuric acid is its corrosivity and toxicity. Inhalation, ingestion, or contact with sulfuric acid could cause severe injury, burns, or death. A fire involving sulfuric acid could produce irritating, corrosive, or toxic gases, and reaction with water may generate heat that would increase the concentration of fumes in the air.

As an immediate precautionary measure, a spill or leak involving sulfuric acid should be isolated for a distance of at least 50 meters (150 feet) in all directions. If a rail or truck tank car containing sulfuric acid is involved in a fire, the area out to 800 meters (0.5 mile) in all directions should be isolated, and evacuation out to 800 meters (0.5 mile) should be considered.

The potential hazard associated with sodium hydroxide is its toxicity. Inhalation, ingestion, or contact with sodium hydroxide could cause severe injury or death. A fire involving sodium hydroxide could produce irritating, corrosive, or toxic gases.

As an immediate precautionary measure, a spill or leak involving sodium hydroxide should be isolated for a distance of at least 50 meters (150 feet) in all directions. If a rail or truck tank car containing sodium hydroxide is involved in a fire, the area out to 800 meters (0.5 mile) in all directions should be isolated, and evacuation out to 800 meters (0.5 mile) should be considered.

4.7.2 ACTION ALTERNATIVE

This section analyzes the impacts of the Action Alternative on transportation within the region of influence. The methods used and the impacts analyzed are the same as those for the Proposed Action.

4.7.2.1 Car and Truck Traffic

The traffic study discussed in Section 4.7.1.1 was based on 1,078 employee trips and truck shipments per day. During the construction and operations phases under the Action Alternative, there would be less than 700 shipments per day. Therefore, the traffic impacts under the Action Alternative would be similar to those presented for the Proposed Action.

Road Damage

The increased truck traffic associated with the Action Alternative would result in increased pavement deterioration. This pavement deterioration would result from the weight of vehicles being applied to a pavement surface, and is dependent on truck characteristics, pavement characteristics, and environmental factors. The report *Impact of Kansas Grain Transportation on Kansas Highway Damage Costs*, (Babcock and Bunch 2002) evaluated the costs associated with increased pavement deterioration from increased grain shipments by truck as a result of hypothetical shortline railroad abandonments. These costs were estimated to be $0.17 per truck-mile ($0.11 per truck-kilometer). If it is assumed that biomass shipments are made in a manner similar to these grain shipments, the annual cost of the pavement damage caused by the additional truck shipments of biomass would be about $210,000. The shipping of other materials, such as chemicals and waste, would also result in pavement damage. Quantitative estimates of the pavement damage caused by shipments of these other materials have not been made because the transportation system used for these materials would not be similar to the transportation system discussed in the above report (Babcock and Bunch 2002) for grain shipments. However, estimating the highway pavement damage costs attributed to truck (for example, tractor-trailers) traffic is the subject of research efforts being conducted at the Mid-American Transportation Center.

4.7.2.2 Rail Traffic

The rail traffic estimated under the Action Alternative would be similar to the rail traffic estimated for the Proposed Action. Therefore, the impacts on rail traffic for the Action Alternative would be similar to those presented for the Proposed Action in Section 4.7.1.2.

4.7.2.3 Traffic Fatalities

This section presents the estimated number of highway-related and rail-related traffic fatalities near the Biorefinery Project site as a result of the increased truck and rail traffic associated with the Action Alternative. As with the Proposed Action, impacts associated with fatalities are discussed in terms of the construction phase and the operations phase.

4.7.2.3.1 *Construction Phase*

Construction Materials

During the construction of the biorefinery, materials such as steel, concrete, piping, cabling, railroad tracks, and sub-ballast would be shipped to the Biorefinery Project site. Table 4-34 lists the quantities of these materials and the associated number of shipments that would be required to ship these materials to the Project site using trucks under the Action Alternative. As with the Proposed Action, all construction material shipments were assumed to originate in Wichita, and construction and demolition wastes were assumed to be disposed of at a landfill within 30 miles (48 kilometers) of the Project site.

Table 4-34. Construction material and waste quantities and shipments under the Action Alternative.

Material	Quantity	Number of truck shipments
Steel	4,600 tons (4,200 metric tons)	418
Concrete	35,000 cubic yards (27,000 cubic meters)	2,676
Fill material	210,000 cubic yards (161,000 cubic meters)	16,056
Asphalt paving	38,000 square feet (3,500 square meters)	108
Storm sewer pipe	2,000 linear feet (610 linear meters)	7
Internal and external water pipe	35,000 linear feet (11,000 linear meters)	11
Railroad tracks	9,000 linear feet (2,700 linear meters)	17
Rock sub-ballast	6,000 cubic yard (4,600 cubic meters)	459
Mechanical process piping	45,000 linear feet (14,000 linear meters)	14
Electrical and control cables	155,000 linear feet (47,200 linear meters)	48
Cable trays	12,000 linear feet (3,700 linear meters)	4
Fencing	20,000 linear feet (6,100 linear meters)	7
Gravel	48,000 cubic yards (37,000 cubic yards)	3,670
Firewater piping	6,000 linear feet (1,800 linear meters)	2
Construction and demolition wastes	63,000 tons (57,000 metric tons)	5,076
Total		28,573

Source: Roach 2009j.

The construction phase would last approximately 18 months. During this phase, construction materials and wastes would be shipped about 11 million round-trip miles (18 million round-trip kilometers). Based on a Kansas statewide large truck fatality rate of 11.9 traffic fatalities per 100 million truck-miles (7.39

per 100 million vehicle-kilometers) traveled, there would be an estimated 1.3 traffic fatalities from the shipment of these construction materials. For perspective, over the same period of 18 months, there would be an estimated 670 traffic fatalities in Kansas and 41 traffic fatalities in the nine counties surrounding the Biorefinery Project site.

Commuting Workers

During the construction phase, a peak of 224 workers would commute back and forth to the Biorefinery Project site, and a total of 9,807 worker-weeks would be required for construction (Roach 2009j). While some workers could choose to live in Hugoton, other workers could choose to live in the other cities surrounding the Project site, such as Liberal, Sublette, Ulysses, Johnson City, Elkhart, Kansas, or Guymon, Oklahoma. Based on the distances presented in Chapter 3, Table 3-15, it is likely the workers would commute from a distance of 50 miles (80 kilometers) or less.

The construction phase would last approximately 18 months. During this phase, commuting workers would travel about 5.1 million round-trip miles (8.2 million round-trip kilometers). Based on a Kansas statewide fatality rate of 1.5 traffic fatalities per 100 million vehicle-miles (0.93 per 100 million vehicle-kilometers) traveled, there would be an estimated 0.077 traffic fatality for commuting workers during the construction phase. For perspective, over the same period of 18 months, there would be an estimated 670 traffic fatalities in Kansas and 41 traffic fatalities in the nine counties surrounding the Project site.

4.7.2.3.2 *Operations Phase*

Materials Used or Produced During Operations

During the operations phase, materials such as biomass, chemicals, denatured ethanol product, and wastes would be shipped to or from the Biorefinery Project site. Table 4-35 lists the quantities of these materials and the associated annual number of shipments that would be required to ship these materials to the Project site under the Action Alternative.

The operations phase would continue for 30 years. During this phase, the materials listed in Table 4-35 would be shipped about 91 million round-trip miles (150 million round-trip kilometers) under the Action Alternative. Based on a Kansas statewide large truck fatality rate of 11.9 traffic fatalities per 100 million truck-miles (7.39 per 100 million truck-kilometers) traveled and a national railroad fatality rate of 12.6 fatalities per 100 million railcar-miles (7.83 per 100 million railcar-kilometers) traveled, there would be an estimated 11 traffic fatalities from the shipment of these materials. For perspective, over the same period of 30 years, there would be an estimated 13,400 traffic fatalities in Kansas and 820 traffic fatalities in the nine counties surrounding the Project site.

Commuting Workers

During the operations phase, 34 workers would commute back and forth to the Biorefinery Project site. As with construction workers, some workers could choose to live in Hugoton, other workers could choose to live in the other cities surrounding the Project site, such as Liberal, Sublette, Ulysses, Johnson City, Elkhart, Kansas, or Guymon, Oklahoma. Based on the distances presented in Chapter 3, Table 3-15, it is likely the workers would commute from a distance of 50 miles (80 kilometers) or less.

Table 4-35. Materials that would be used or produced during the operations phase under the Action Alternative.

Material	Annual quantity	Number of shipments (per year)[a]
Biomass	317,725 tons (wet) [288,234 metric tons (wet)]	27,234
Chemicals		
Sodium hydroxide	949,200 pounds (430,500 kilograms)	20
Aqueous ammonia	3,704,400 pounds (1,680,300 kilograms)	75
Sulfuric acid	11,415,600 pounds (5,178,000 kilograms)	61[b]
Urea	88 tons (80 metric tons)	4
Gasoline (denaturant)	563,379 gallons (2,132,580 liters)	67
Cellulase	7,581 tons (6,877 metric tons)	307
Corn syrup	525 tons (476 metric tons)	22
Lime	3,906 tons (3,543 metric tons)	44[b]
Corrosion inhibitor	35 gallons (130 liters)	4
Magnesium hydroxide	194,250 pounds (88,110 kilograms)	4
Diammonium phosphate	21,000 pounds (9,500 kilograms)	1
Herbicides, pesticides, rodenticides, other chemicals	100 pounds (50 kilograms)	4
Diesel fuel	793,647 gallons (3,004,220 liters)	106
Fluidized bed sand	518 tons (470 metric tons)	47
Denatured ethanol product	12 million gallons (45 million liters)	421[b]
Waste		
Dirt and fines	700 tons (640 metric tons)	64
Lignin	19,000 tons (17,000 metric tons)	203[b]
Boiler ash	11,365 tons (10,310 metric tons)	1,032
Hazardous waste	1 ton (0.9 metric tons)	4
Gasification ash	8,524 tons (7,733 metric tons)	774
Municipal solid waste	26 tons (24 metric tons)	3
Total		30,501

Source: Roach 2009j.
a. All shipments made using trucks except where noted.
b. Shipments made using rail.

The operations phase is expected to continue for 30 years. During this period, commuting workers would travel about 27 million round-trip miles (43 million round-trip kilometers). Based on a Kansas statewide fatality rate of 1.5 traffic fatalities per 100 million vehicle-miles (0.93 per 100 million vehicle-kilometers) traveled, there would be an estimated 0.40 traffic fatality for commuting workers during the operations phase. For perspective, over the same period of 30 years, there would be an estimated 13,400 traffic fatalities in Kansas and 820 traffic fatalities in the nine counties surrounding the Project site.

4.7.2.4 Hazardous Materials Transportation Accidents

The types and quantities of hazardous materials that would be shipped under the Action Alternative would be similar to the types and quantities of hazardous materials that would be shipped under the Proposed Action. Therefore, the impacts of hazardous materials transportation accidents under the Action Alternative would be similar to those presented for the Proposed Action in Section 4.7.1.4.

4.7.3 SUMMARY OF TRANSPORTATION IMPACTS

For the Proposed Action, during the construction and operations phases, DOE estimates there would be 32 traffic fatalities due to shipments to and from the Biorefinery Project site. The majority of these fatalities (30) would be due to shipments of biomass, chemicals, denatured ethanol product, and waste. For the Action Alternative, during the construction and operations phases, there would be an estimated 13 traffic fatalities due to shipments to and from the Project site. As with the Proposed Action, the majority of these fatalities (11) would be due to shipments of biomass, chemicals, denatured ethanol product, and waste. For perspective, over the operations period of 30 years, there would be an estimated 13,400 traffic fatalities in Kansas and 820 traffic fatalities in the nine counties surrounding the Project site.

Based on the traffic impact analysis, no roadway improvements were identified as necessary to help truck and employee traffic access the Biorefinery Project site for either the Proposed Action or Action Alternative. The additional rail traffic from the Project site would also not adversely affect the operations of the Cimarron Valley Railroad for the action alternatives.

The increased truck traffic associated with the Proposed Action and the Action Alternative would result in increased pavement deterioration. For biomass shipments associated with the Proposed Action, the annual cost of this pavement damage is estimated to be $680,000. For the Action Alternative, the annual cost of this pavement damage is estimated to be $210,000.

4.8 Aesthetics

This section describes the potential aesthetics, that is, visual resources, noise, and odor, impacts associated with the Proposed Action and Action Alternative. Section 4.8.1 describes the impacts of the Proposed Action and Section 4.8.2 describes the impacts of the Action Alternative.

4.8.1 PROPOSED ACTION

4.8.1.1 Visual Resources

Construction of the biorefinery may cause some short-term and temporary visual impacts to the immediate area of the biorefinery [that is, on the 385-acre (1.6-square-kilometer) parcel]. The main source of visual obscurants would be fugitive dust from construction activities. Best management practices such as wetting dirt roads would help to alleviate the increase in fugitive dust. Onsite haul roads eventually would be paved, so the increased amount of fugitive dust would only last during the initial 18-month construction phase. In addition, the equipment used on or around the biorefinery parcel to support the construction activities would contribute to an increased visibility of traffic on and around the biorefinery, as well as an increased visibility of construction equipment, such as cranes. However, the increased visibility of vehicles and construction equipment would only occur during the 18-month construction phase.

Once built, the structures making up the biorefinery would be in contrast to the surrounding agricultural areas, but similar to the structures at the West Industrial Park, Cargill Inc., and Seaboard Farms. The industrial park, Cargill, and Seaboard Farms are all located adjacent to and south of the biorefinery area; therefore, the distance from the biorefinery parcel to the city of Hugoton would be the same as the distance from the industrial park to Hugoton. The structures at the West Industrial Park are predominantly one or two stories and constructed of corrugated metal. The Stevens County Asphalt Plant, located in the industrial park, contains tanks, but the tanks are not more than a few stories tall. Cargill and Seaboard Farms contain taller structures (such as grain storage silos) than those at the West

Industrial Park (Figure 4-5); therefore, these structures are the most visible from the city of Hugoton. Figure 4-6 shows Cargill and Seaboard Farms in the distance while driving west out of Hugoton along

04071024.ai

Figure 4-5. View of structures at Cargill and Seaboard Farms.

04071025.1.ai

Figure 4-6. View to the west from Road P just outside of the Hugoton city boundary looking at Cargill and Seaboard Farms.

Road P. Due to the flatness of the terrain, the biorefinery structures would appear similar to the multi-story grain storage silos and elevators at Cargill and Seaboard Farms to a viewer in Hugoton. Figures 4-7 and 4-8 are photos of two grain-to-ethanol facilities that are similar to how the Abengoa biorefinery would appear. The structures at these facilities are mostly constructed of metal and do not appear taller than the grain elevators at Cargill and Seaboard Farms. Figure 4-9 shows a rendering of the biorefinery from the southwest (golf course). The rendering in Figure 4-10 shows a closer view of the biorefinery from the northwest. From this rendering, the relative heights of the structures can be determined as well as the size of the onsite biomass storage area. The tallest structure is shown as approximately 115 feet (35 meters), but many of the structures are 40 feet or less. To aid in mitigating impacts on the view to the west from Hugoton, the 425-acre (1.7-square-kilometer) buffer area would continue to be used as agricultural land under the Proposed Action, so activities on this parcel of land would not cause any new visual impacts to the surrounding area.

Source: Roach 2009y.
04071026.2.ai

Figure 4-7. Abengoa Bioenergy bioethanol facility in Ravenna, Nebraska.

Source: Roach 2009y.
04071027.3.ai

Figure 4-8. Abengoa Bioenergy bioethanol facility in York, Nebraska.

Because the golf course is approximately 0.25 mile (0.40 kilometer) west and adjacent to the Biorefinery Project site, the structures at the biorefinery would be visible from the golf course. However, views of the biorefinery from the golf course would be similar to those of the existing structures at the West Industrial Park, Cargill, and Seaboard Farms.

The West Industrial Park is between US-56 and the biorefinery area, thus viewpoints for travelers driving east or west on US-56 should not change substantially. Although the biorefinery structures would most likely be visible from US-56, the industrial park structures remain the closest structures to the highway.

The biorefinery would operate 24 hours a day, 350 days a year. Therefore, the biorefinery would use lighting that would be visible in the night sky. The Hugoton Municipal Airport, which is approximately 0.5 mile (0.8 kilometer) from the biorefinery and southwest of the city of Hugoton, is a current source of night lighting; therefore, the biorefinery would not be the sole source of night lighting in the area. To aid in mitigating impacts from night lighting at the biorefinery, directional or downward-facing light and the minimum amount of lighting needed for safe operation should be considered.

An approximately 1.5-mile (2.4-kilometer)-long transmission line would be built under the Proposed Action so that power could be transmitted from the biorefinery to the regional power grid. The transmission line would start on the north border of the biorefinery parcel, travel east along Road P, and then north along Road 11 to a substation. The new transmission line would be visible along Road P and Road 11.

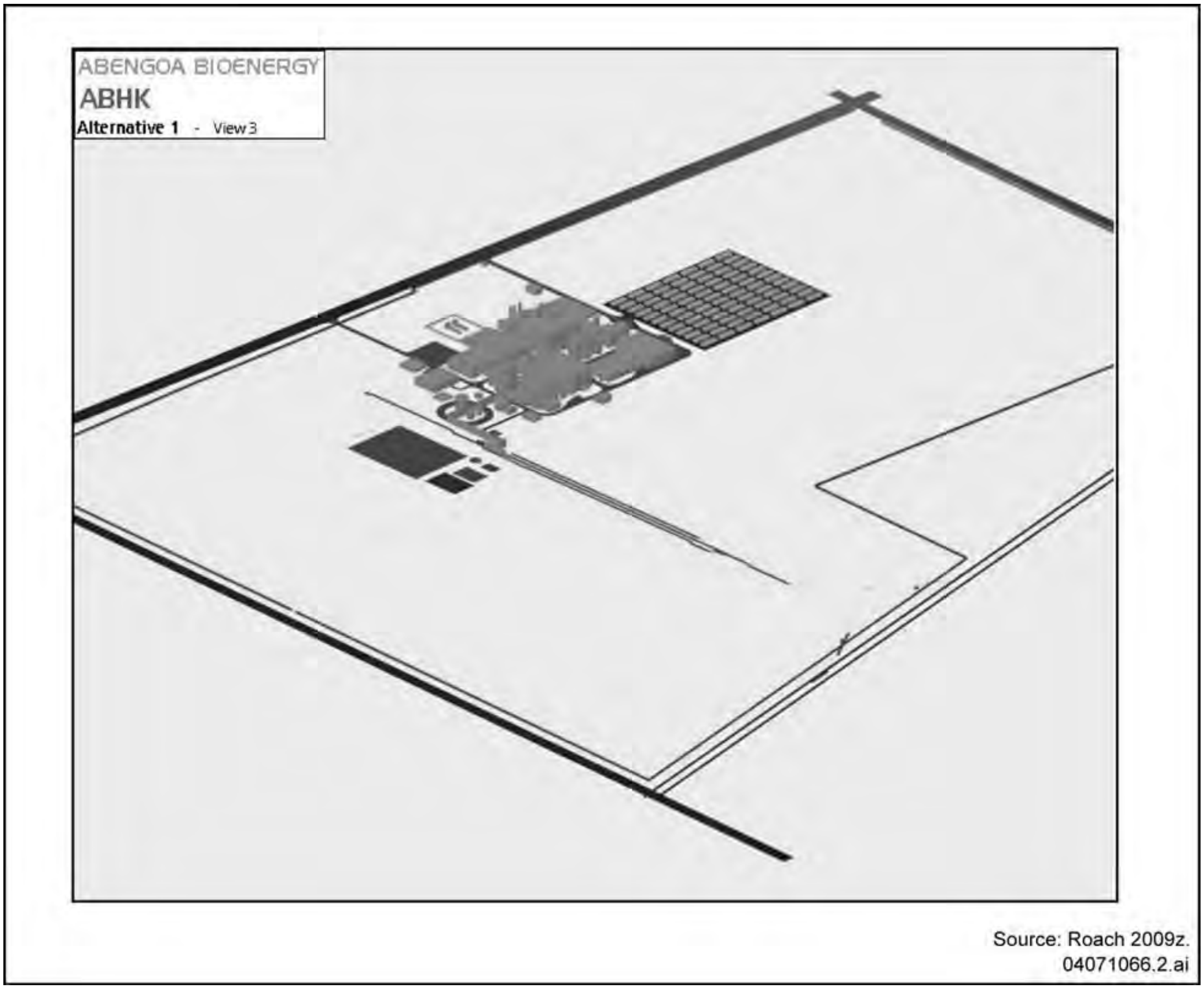


Figure 4-9. Rendering of the biorefinery from the southwest (golf course).

Emission or water vapor plumes from the biorefinery could also be visible. However, according to *Kansas Administrative Regulation* K.A.R 28-19-650, "Emissions Opacity Limits," visible air emissions, excluding water vapor, from any emission source constructed after January 1, 1971 are not to exceed 20-percent opacity. Emission plumes with 20-percent opacity or less should disperse quickly and not cause visual obstruction. Since the biorefinery would be a newly constructed emission source, it would adhere to the opacity requirement; therefore, any visible emission plumes from the biorefinery would have opacity of 20 percent or less and should disperse quickly. According to the approved method for determining opacity listed in K.A.R. 28-19-650, opacity observations are to be made within regions of the plume where water vapor is not present. Therefore, if a plume contains mostly water vapor, it may appear to exceed the 20-percent opacity limits, especially in colder temperatures. Because the biorefinery would contain cooling towers, it is possible that there would be plumes containing high amounts of water vapor and that these plumes could be more visible with colder ambient temperatures.

The Proposed Action includes seven offsite storage locations within 30 miles (48 kilometers) of the Biorefinery Project site. The offsite storage facilities would be on dry, marginal land centrally located to the harvesting areas and would contain bales of biomass feedstock stored in sacks. There would not be any permanent structures at the offsite storage locations. The offsite storage facilities would appear

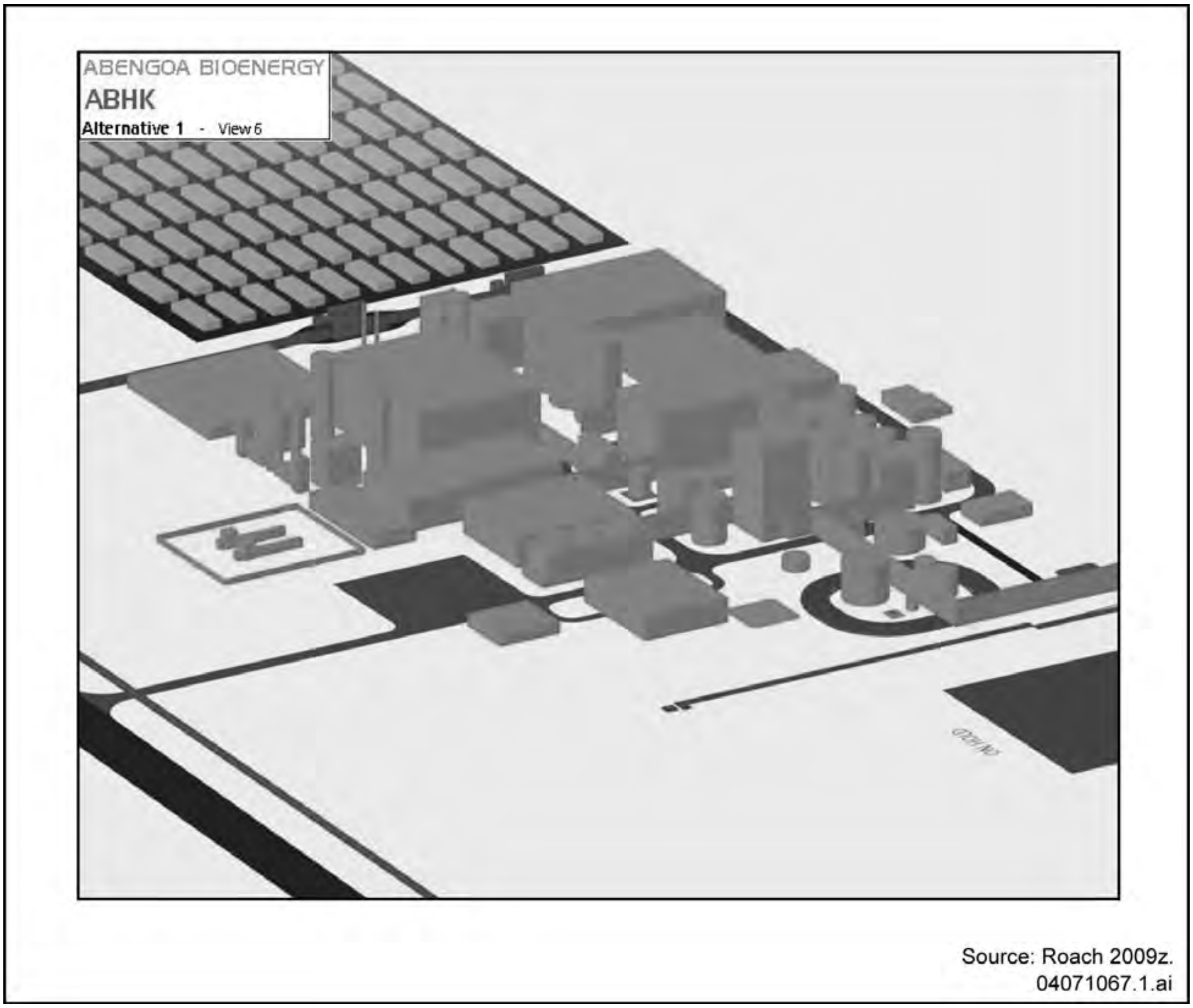


Figure 4-10. Rendering of the biorefinery from the northwest.

similar in nature to the surrounding agricultural land, and would therefore not have any visual impacts to the area surrounding the offsite storage facilities.

4.8.1.2 Noise

The following sections describe potential noise impacts to workers (*occupational noise*) and to the public (*nuisance noise*) during construction and operations. The region of influence is approximately 1 mile (1.6 kilometers) around the Biorefinery Project site and includes the entire city of Hugoton. Noise impacts are evaluated with respect to the potential for:

- Annoyance. Noise can impact the performance of various everyday activities such as communicating and watching television in residential areas. Sound levels that cause annoyance vary greatly by individual and background conditions.

- Hearing hazard. The Occupational Safety and Health Administration has identified that the maximum permissible continuous noise level that workers may be exposed to without controls is 90

> *A-weighted decibels* (dBA) for a duration of 8 hours per day [29 CFR 1910.95(b)(2)]. Whenever employee noise exposures equal or exceed an 8-hour time-weighted average sound level of 85 dBA, a hearing conservation program must be administered [29 CFR 1910.95(c)(1)]. These values are for a duration of 8 hours. Employees can be exposed to greater sound levels for shorter durations.

Sound levels naturally attenuate due to distance. The energy in sound waves (and thus the sound intensity) drop with the square of the distance to the sound source. Thus, for *stationary* sources of noise, sound levels attenuate 6 decibels per doubling of distance. In addition to distance alone, sound levels are further attenuated when sound paths lie close to freshly plowed or vegetation-covered ground. Sound paths are sometimes interrupted by manmade noise barriers, buildings, or by vegetation (Hanson et al. 2006).

The decibel scale is a logarithmic, or relative, scale. This means that as the sound pressure is doubled (or the energy in the sound), the index increases by approximately three times. A sound level of 100 dBA contains twice the energy of a sound level of 97 dBA. This means when two noise sources of the same level are added, the resulting sound level will be increased by 3 dBA, not doubled. The reason for measuring sound this way is that human ears (and minds) perceive sound in terms of the logarithm of the sound pressure, rather than the sound pressure itself. A rule of thumb is that if the sound level increases by 10 dBA, the subjective loudness of the sound is doubled. Outside of the laboratory, a 3-dBA change in sound level is considered a barely discernible difference. A change in sound level of 5 dBA will typically result in a noticeable community response (Rogers et al. 2006).

Section 4.4 discusses noise impacts on wildlife.

4.8.1.2.1 *Impacts related to Construction*

Impacts to Workers

Noise during construction would include noise from large machinery such as trucks, cranes, bulldozers, dumpers, front-loaders, and excavators. The noise levels generated by construction equipment vary greatly depending on factors such as the type of equipment, the specific model, the operation being performed, and the condition of the equipment (Hanson et al. 2006). Typical noise levels from representative pieces of equipment at 50 feet (15 meters) are as follows: bulldozer (85 dBA), truck (88 dBA), front-loader (85 dBA), crane (83 to 88 dBA) (Hanson et al. 2006). All contractors using construction equipment at the site would need to comply with 29 CFR 1910.95 and should use the principle of controlling noise at the source whenever practical. As described above, 29 CFR 1910.95 sets two action levels, 85 dBA and 90 dBA, both averaged over 8 hours. All potentially noisy equipment brought to the Biorefinery Project site would be fitted with appropriate silencing equipment. Contractors would be required to perform assessments as to whether their employees or others would be likely to be exposed to noise at or above the action levels. If action levels were met, contractors would be required to administer a hearing conservation program or use appropriate controls in order to comply with 29 CFR 1910.95. Best management practices for limiting construction noise would also be employed as described in Chapter 6. Therefore, no noise impacts to construction workers are expected.

Impacts to the Public

Figure 4-11 shows the region of influence evaluated for noise impacts and identifies the noise-*sensitive receptors* including residences, schools, libraries, places of worship, and medical centers. The closest residence is at the northwest boundary of the biorefinery, approximately 0.6 mile (1 kilometer) from the

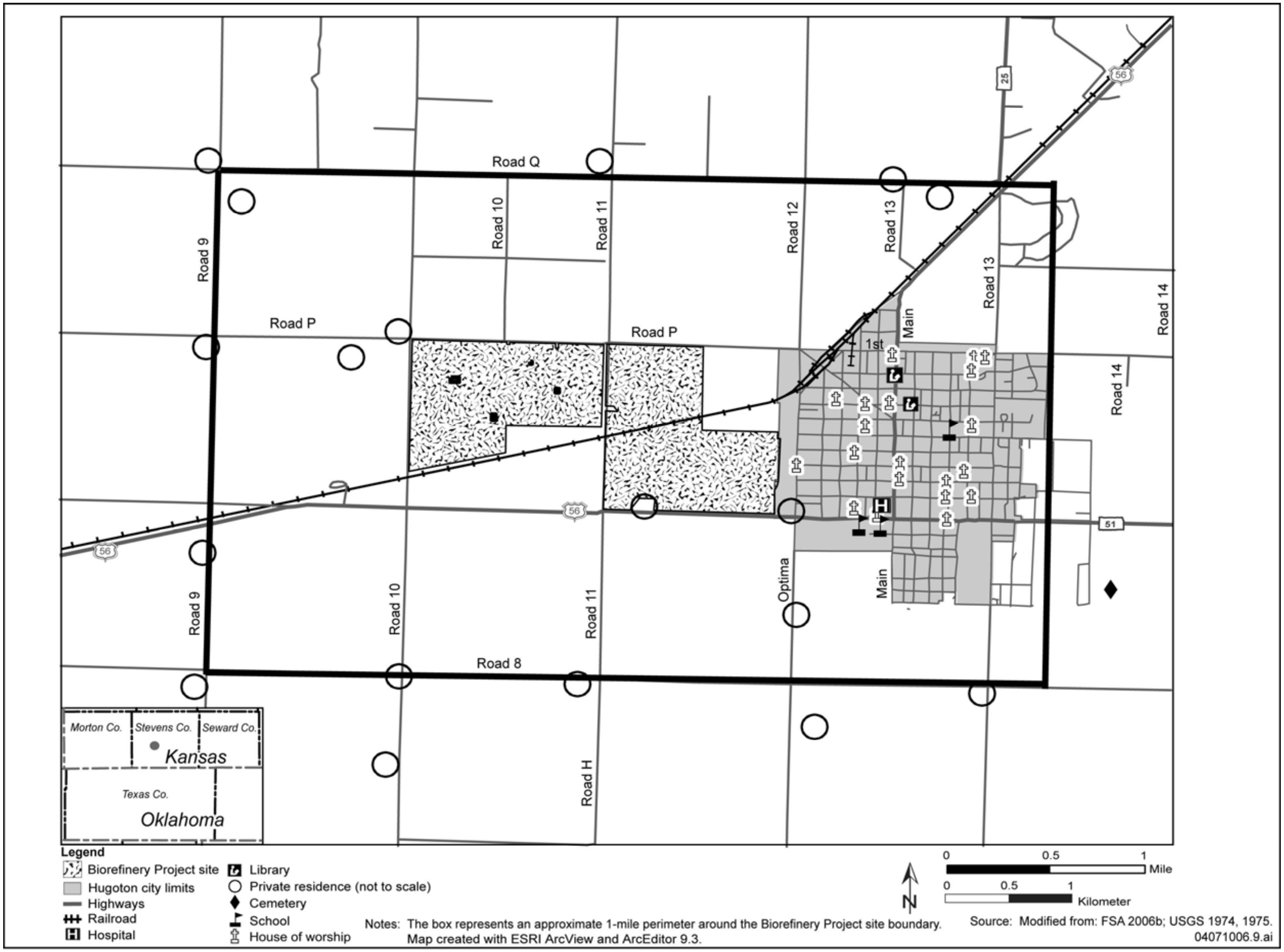


Figure 4-11. Region of influence evaluated for noise impacts showing the noise-sensitive receptors.

area that would generate the highest noise levels. The nearest school, library, and hospital are each approximately 2 miles (3 kilometers) away in the city of Hugoton. The nearest place of worship is approximately 1.5 miles (2.4 kilometers) away in the city of Hugoton. The closest point on the Biorefinery Project site boundary to the highest process noise levels would be on Road P, approximately 600 feet (200 meters) directly to the north.

Short-term impacts during construction would include noise from large machinery such as trucks, cranes, bulldozers, dumpers, front-loaders, and excavators. This type of construction equipment generates noise levels of about 85 dBA to 88 dBA at 50 feet (15 meters). The magnitude of construction noise impacts would depend on the type of construction activity, the noise level generated by various pieces of construction equipment, the duration of the activity, the distance between the activity and noise-sensitive receptors, and any shielding effects provided by local barriers and topography (Hanson et al. 2006). A reasonable but conservative assumption is that three pieces of loud equipment would operate simultaneously and continuously for one hour or more. The combined sound level of three pieces of the loudest equipment (scraper, truck, and bulldozer) is 92 dBA measured at 50 feet.

To predict noise levels at various distances from an active construction site, an attenuation rate of 6 dBA per doubling of distance to a receptor is assumed. The nearest receptor to the biorefinery construction site is a residence at the northwest property boundary located approximately 0.6 mile (1 kilometer) from the construction site. At that distance, the combined source level of 92 dBA would attenuate to approximately 56 dBA. This sound level is only slightly higher than the EPA recommendation of an outdoor sound level of no more than 55 dBA for avoidance of annoyance (EPA 1978). Noise and sound levels would be typical of new construction activities and would be intermittent. These impacts would be lessened by confining construction activities to normal working hours and employing noise-controlled construction equipment to the extent possible. Some work may need to occur outside normal working hours. This work would typically be less noisy, for example, x-ray examination of welds on pipes. If noisier construction work was necessary between 7 p.m. and 7 a.m., best management practices such as the following noise abatement measures would be employed: silencers on equipment and tools, sound barriers at specific points around work areas, and avoidance of noisy work outside of buildings. No standardized criteria have been developed for assessing construction-noise impacts. *Transit Noise and Vibration Impact Assessment* (Hanson et al. 2006) recommends not exceeding a 1-hour equivalent level of 90 dBA during the daytime in a residential area and 100 dBA in an industrial or commercial area. The nearest residence may experience some annoyance to the construction noise; however, the impact would be small because of the magnitude of the predicted noise level (56 dBA) and because the noise would be temporary.

Vehicle traffic traveling to and from the construction area also would contribute to construction noise. During construction, material shipments would average about 69 trucks per day. Trucks traveling along US-56 from the northeast would pass through a residential area in the northwest corner of the city of Hugoton. Assuming all trucks would use this route, these residences would experience 69 truck passes between 7 a.m. and 9 p.m. This equates to one truck every 12 minutes during this period. The typical noise level for trucks at highway speed [approximately 55 miles per hour (89 kilometers per hour)] is approximately 90 dBA. Trucks passing through the city of Hugoton would be traveling at a lower speed, so lower noise levels would be typical, but would still be sufficient to interfere frequently with outdoor conversations and cause annoyance indoors. Section 4.7 discusses transportation-related impacts.

Construction noise would subside after construction was complete. Construction is expected to last 18 months.

4.8.1.2.2 *Impacts related to Operations*

Impacts to Workers

Workers also would be exposed to noise during biorefinery operations. A noise monitoring survey at the Abengoa Bioenergy facility in Ravenna, Nebraska, evaluated noise impacts to five workers. The time-weighted average dose for 8 hours for the five workers ranged from 78.0 to 89.5 dBA. One employee exceeded the Occupational Safety and Health Administration action level of 85 dBA, which requires a hearing conservation program. No employee exceeded the Occupational Safety and Health Administration action level of 90 dBA, which requires that controls be put in place. The noise monitoring survey showed that the noise level in the majority of the facility was above 85 dBA and recommended that anyone entering the facility areas be required to wear hearing protection. Noise impacts to workers from the Proposed Action are expected to be similar as those at the facility in Ravenna and would not cause hearing loss with proper hearing protection procedures and compliance with 29 CFR 1910.95, including a hearing conservation program that includes employee monitoring, employee notification, audiometric testing program, hearing protection, and employee training.

If employees were subjected to sound levels that exceeded the values in Table 4-36, administrative or engineering controls would be used. As shown in Table 4-36, employees may be exposed to sound levels greater than 90 dBA but for shorter periods than 8 hours. Engineering controls could include silencers in equipment such as grain/biomass handling systems, stacks, dust collection system, and boilers; sound barriers at specific points on the perimeter; and acoustic panel enclosures for buildings or specific pieces of equipment. If administrative or engineering controls are inadequate, personal protective equipment would be provided. Signs would be posted indicating where hearing protection is required.

Table 4-36. Occupational Safety and Health Administration permissible noise exposures without controls.

Duration per day (hours)	Sound level (dBA)
8	90
6	92
4	95
3	97
2	100
1	105
½	110
¼ or less	115

Source: 29 CFR 1910.95(b)(2).
dBA = A-weighted decibel.

Impacts to the Public

Long-term impacts to the public would include noise from biorefinery operations. Areas within the Biorefinery Project site with the highest noise levels would be the Biomass Receiving Area (100 dBA), the Steam Generation System (99 dBA), the Decanting Area (98 dBA), and the Distillation, Dehydration and Evaporation Building (97 dBA). To calculate the noise impacts to the public from operations, the four noisiest areas were combined to give a maximum sound level of 105 dBA. This corresponds to an hourly *equivalent sound level* of 71 dBA at 50 feet (15 meters). Three of these areas (the Steam Generation System, the Decanting Area, and the Distillation, Dehydration and Evaporation Building) would operate 24 hours per day, while the Biomass Receiving Area would operate 16 hours per day. To be conservative, this analysis assumed that all four areas would operate 24 hours per day. Because people are more sensitive to nighttime noise, the *day-night average sound level* accounts for this sensitivity by applying a 10-dBA weighting to the nighttime hours between 10 p.m. and 7 a.m. The actual noise level does not change, but adding 10 dBA accounts for the perception that the sound is noisier.

The day-night average sound level was calculated to be 75 dBA at 50 feet (15 meters). This noise level would attenuate to 39 dBA (below background) at approximately 0.6 mile (1 kilometer), the distance to the nearest receptor, a residence located at the northwest boundary of the Biorefinery Project site. This does not take into account any attenuation from enclosures or buildings. Current biorefinery design plans show all biomass grinding operations contained within enclosures or buildings, primarily to help capture and control dust emissions, but also to assist in the attenuation of noise. At 0.6 mile and beyond, noise from operations would not be distinguishable from other background sources of noise. Therefore, it is expected that members of the public would not experience impacts from noise from biorefinery operations, as residences, schools, libraries, places of worship, and medical centers are located at least 0.6 mile away.

In addition, noise would be generated from increased traffic on state and county roads from commuting workers and truck and rail traffic to and from the biorefinery area during delivery of raw materials and load-out of finished product. Noise would also occur from train coupling/de-coupling actions and other material transfer activities. The most direct route to the Biorefinery Project site from the north and east is via US-56 to Road P. Other routes to the Project site could include those from the north and west on Road P, from the south and west on US-56/K-51, and from the south and east on US-56/K-51. During operations, 175 trucks per day are anticipated (Roach 2009a).

Trucks traveling along US-56 from the northeast would pass through a residential area in the northwest corner of the city of Hugoton. Assuming 50 percent of all trucks would use this route, these residences would experience 88 truck passes between 7 a.m. and 9 p.m. This equates to approximately one truck every 9.5 minutes during this period. The typical noise level for trucks at highway speed [approximately 55 miles per hour (89 kilometers per hour)] is approximately 90 dBA. Trucks passing through the city of Hugoton would be traveling at a lower speed, so lower noise levels would be typical, but would still be sufficient to interfere frequently with outdoor conversations and cause annoyance indoors.

Trucks traveling from the south and east along US-56/K-51 would pass through the southern part of the city of Hugoton. Noise-sensitive receptors along this route include the Stevens County Hospital, as well as several schools, residences, and places of worship. Assuming 20 percent of trucks used this route, these receptors would experience 35 truck passes between 7 a.m. and 9 p.m. This equates to approximately one truck every 24 minutes during this period. These trucks would continue west on US-56/K-51 and likely travel north on Road 10 to Road P to access the biorefinery and thus would pass by the residence at the northwest boundary of the Biorefinery Project site. In addition, trucks traveling from the south and west on US-56/K-51 would likely travel north on Road 10 to Road P and trucks traveling from the north and west on Road P would also pass by this residence. Assuming 25 percent of all trucks traveled from the south and west and 5 percent of all trucks traveled from the north and west, this residence would experience 50 percent of the total truck traffic, or a total of 88 truck passes between 7 a.m. and 9 p.m. This equates to approximately one truck every 9.5 minutes during this period. Most of the trucks passing by this residence would be turning and thus traveling at a lower speed, with lower noise levels, but would still be sufficient to interfere with outdoor conversations and potentially cause annoyance indoors. Table 4-37 summarizes the number of truck passes along various potential transportation routes. Section 4.8 discusses potential impacts to transportation.

Table 4-37. Truck traffic along various transportation routes to the Project site during operations under the Proposed Action.

Route to biorefinery	Noise-sensitive receptors along route	Percent of trucks assumed to use this route	Number of trucks per day	Elapsed time between truck passes (minutes)
From north and east via US-56 to Road P	Residential area in northwest corner of city of Hugoton	50	88	9.5
From north and west on Road P	Residence at northwest property boundary of the Project site	5	9	93
From south and west on US-56/K-51[a]	None	25	44	19
From south and east on US-56/K-51[a]	Stevens County Hospital, several residences, schools, and places of worship	20	35	24

a. Trucks using these routes would likely travel north on Road 10 to Road P to access the biorefinery. Therefore, 88 trucks per day would travel Road P and pass by the residence at the northwest boundary of the Project site. This equates to one truck pass every 9.5 minutes.

Additional rail traffic is also expected on the Cimarron Valley Railroad and a rail spur would be built from the biorefinery south to the existing Cimarron Valley Railroad. The main components of rail noise are the exhaust of the diesel engines, cooling fans, general engine noise, horn noise, and the wheel-rail interaction. The amount of noise created by the wheels on the rails depends on train speed; the amount of engine noise depends on the throttle setting. Wheel squeal can sometimes occur on curved sections of track where the radius of curvature of the track is small. An estimated 1,303 railcars per year, the equivalent of about 4 per day, would be used during operations for delivery of raw materials and load-out of finished product (Roach 2009a). This is equivalent to about 51 additional trains per year (Section 4.7.1.2) This small increase in rail traffic would not add significant noise to the existing environment.

Offsite storage areas would be used to store the biomass prior to transport by truck to the biorefinery. Sources and levels of noise at the offsite storage areas would include two-bale squeeze operating from 7 a.m. to 7 p.m. at 75 dBA. This corresponds to an hourly equivalent sound level of 44 dBA at a distance of 50 feet (15 meters). This level is the typical background sound level for agricultural cropland (44 dBA) and, therefore, no significant noise impacts are expected.

4.8.1.3 Odor

Odor analysis of the Proposed Action is based on identifying the sources of odorous compounds and determining the concentrations of these odorous compounds at receptor points, such as residences, in Hugoton. The analysis compares modeled concentrations of odorous compounds with *odor threshold* values published by the American Industrial Hygiene Association (AIHA 1989) and the Journal of Applied Toxicology (Amoore 1983) to determine if the compounds would be detectable. The sources of odors from the Proposed Action generally would be volatile organic compounds, including ethanol, hazardous air pollutants, nitrogen dioxide, and sulfur dioxide; therefore, odor reduction would occur by using engineered controls to minimize the amount of volatile organic compounds, hazardous air pollutants, nitrogen dioxide, and sulfur dioxide. This section discusses the controls that would be used as part of the Proposed Action. Further, the biorefinery would follow an odor control plan similar to that developed for Abengoa Bioenergy's proposed expansion at the existing Colwich, Kansas, facility (Roach 2009ee).

4.8.1.3.1 *Impacts from Biorefinery Construction*

Odorous emissions during construction of the biorefinery would mostly be limited to temporary diesel equipment exhaust. The use of well-maintained construction equipment with appropriate emissions controls would reduce the tailpipe emissions, including odorous compounds. During construction, the onsite haul roads would be paved; thus, asphalt odors would occur during the paving phase of construction. As with the odors from diesel equipment, the asphalt odors would be temporary.

4.8.1.3.2 *Impacts from Biorefinery Operations*

Operation of the biorefinery under the Proposed Action would involve the use of feedstock to produce biofuel (ethanol) and biopower, with excess electricity being sold to the regional power grid. Conversion of feedstock to ethanol has been identified as a potential source of odor; specifically, feedstock fermentation and distillation, ethanol storage and loadout, and equipment leaks. Storage and loadout of the lignin-rich stillage would also be a potential source of odor. Power at the biorefinery would be generated via feedstock directly firing a biomass boiler. The boilers used for power generation would be potential sources of odor under the Proposed Action. The biorefinery would have an emergency diesel engine and an emergency diesel generator. While the emergency equipment would not be in operation on a regular basis, they would be sources of odorous compounds while in operation.

Table 4-2 shows that the biorefinery would be a source of pollutants, including volatile organic compounds and hazardous air pollutants, some of which can be odorous. To determine which of these compounds are odorous, DOE cross-referenced the complete emissions inventory of compounds to two published sources that report detection thresholds of odorous compounds. Those compounds with an odor threshold reported in at least one of the two sources were analyzed further. If a threshold value occurred in both sources, then the lower of the two values was used for the threshold value (AIHA 1989; Amoore 1983).

In order to determine if the odorous compounds would be detectable beyond the boundary of the biorefinery parcel, DOE performed dispersion modeling using the AERMOD model and 5 years (2002 through 2006) of meteorology data that are representative of the climatology of the Hugoton area (Salter 2009b). Complete details of the modeling approach and parameters used in the air dispersion model based on the April 2009 biorefinery design are presented in Appendix F. The receptor grid for the odor impact modeling consisted of the biorefinery parcel fence line, as well as receptor points at the Forewinds Golf Course, West Industrial Park, and the nearest residences and public facilities such as schools and public parks in Hugoton. Figure 4-12 shows the receptor points in Hugoton, the golf course, and the industrial park. If the modeled concentrations at the fence line were less than the odor threshold concentration, then no further analysis was performed. Odors not detectable at the fence line would likewise not be detectable farther away as concentrations disperse. If, however, the concentrations at the

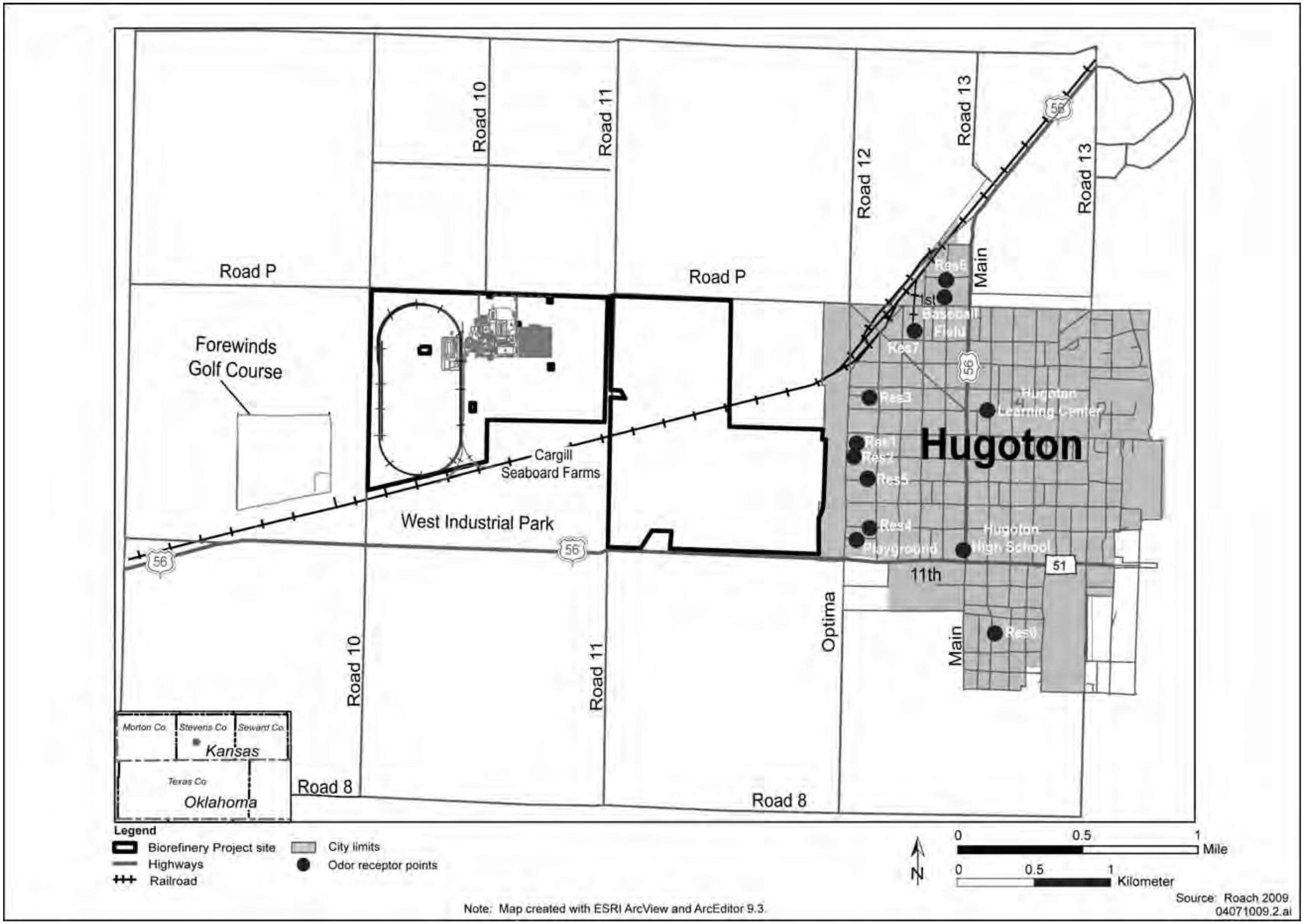


Figure 4-12. Locations of odor receptor points outside of the biorefinery parcel fence line.

fence line were above the odor threshold value, then DOE performed further analyses to determine the concentrations at the stated receptor points. Table 4-38 lists the odorous compounds, the respective odor threshold concentration values, and the maximum model concentrations based on the April 2009 biorefinery design. The biorefinery design parameters and associated values necessary to estimate

Table 4-38. Threshold and predicted concentrations of odorous compounds emitted by the Proposed Action.

Odorous compound	Odor threshold value (μg/m^3)	Maximum model concentration (μg/m^3)	Location of maximum
1,3 Butadiene	1,000[a]	0.039	north fence line
Acetaldehyde	90[b]	73	north fence line
Acetone	8,600[a]	0.23	north fence line
Acrolein	370[b]	7.3	north fence line
Ammonia	3,600[b]	10.7	north fence line
Benzene	38,000[b]	100	north fence line
Biphenyl	5.2[b]	0.12	north fence line
Butane	6,400,000[b]	0.080	north fence line
Carbon disulfide	340[b]	7.5×10^{-3}	north fence line
Carbon tetrachloride	600,000[b]	5.6×10^{-3}	north fence line
Chlorine	230[a]	9.8×10^{-3}	north fence line
Chlorobenzene	3,100[b]	4.1×10^{-3}	north fence line
Chloroform	410,000[b]	3.5×10^{-3}	north fence line
Cumene	40[a]	0.021	north fence line
Dichlorobenzene	1,800[b]	4×10^{-5}	north fence line
Dichloromethane	550,000[a]	0.036	north fence line
Ethane	150,000,000[b]	0.12	north fence line
Ethanol	93,000[a]	290	north fence line
Ethylbenzene	10,000[b]	0.011	north fence line
Formaldehyde	1,000[b]	37	north fence line
Furfural	310[b]	12	west fence line
Hexane	460,000[b]	0.13	north fence line
Hydrogen chloride	1,100[b]	3.2	north fence line
Methanol	5,500[a]	73	north fence line
Naphthalene	200[a]	0.076	north fence line
Nitrogen dioxide	730[b]	1,400	north fence line
	730[b]	460	golf course
	730[b]	240	Hugoton resident #1
Pentane	1,200,000[b]	0.099	north fence line
Phenol	150[b]	6.3×10^{-3}	north fence line
Propane	29,000,000[b]	0.061	north fence line
Propylene	38,000[a]	360	north fence line
Styrene	73[a]	0.23	north fence line
Sulfur dioxide	2,900[b]	84	north fence line
Toluene	80[a]	36	north fence line
Vinyl chloride	7,700,000[b]	2.2×10^{-3}	north fence line
Xylene	1,500[a,c]	25	north fence line

a. AIHA 1989.
b. Amoore 1983.
c. Lowest value of the three isomers (m-Xylene).
μg/m^3 = microgram per cubic meters.

odor-related impacts will not be finalized until after publication of this draft Abengoa Biorefinery Project EIS. The description of the biorefinery and its operation discussed in Chapter 2 represent the latest available information (as of August 2009). The odor-related compound concentrations shown in Table 4-38, however, represent the design parameters and associated values of an earlier biorefinery design (April 2009). In general, the August 2009 design would result in a relative increase in the amount of biomass stored and processed at the biorefinery, as well as a relative increase in the production of ethanol and electricity and associated byproducts and wastes. DOE anticipates the final design parameters and associated values are likely to result in higher concentrations, but preliminary calculations by DOE show that the concentrations would not increase to levels above the odor threshold values.

The emission rates used in the model assumed that proposed emission controls were in place and operational. All concentrations were computed with a 1-hour averaging time, which is the minimum averaging time that can be modeled with AERMOD (EPA 2004). Using the shortest averaging time results in a higher estimated concentration since the emissions have less time to disperse.

The new biorefinery design parameters that will be finalized after publication of this Draft Abengoa Biorefinery Project EIS will not change the modeling procedure, but will change the emission rates input into the computational model. The new rates, anticipated to be greater, will not change the conclusions as characterized above. Preliminary calculations by DOE show that although the odorous compound emissions will increase due to increased amounts of feedstock, they will not increase to levels above the odor threshold values.

Of all the compounds that were modeled, only nitrogen dioxide exceeded the odor threshold value at the biorefinery parcel fence line. However, when modeled at the offsite receptor points, the concentration of nitrogen dioxide dropped below the threshold value. Although the final biorefinery design under the Proposed Action is anticipated to increase the boiler emissions of nitrogen dioxide by nearly 40 percent, compared with the April 2009 design that was used for modeling, preliminary calculations by DOE show that the maximum model concentration of nitrogen dioxide would increase to about 510 micrograms per cubic meter at the golf course, which is still well below the odor threshold of 730 micrograms per cubic meter. Thus, DOE anticipates that although a detectable concentration of one compound may exist at the fence line, residents of Hugoton, workers at the industrial park, and golfers should not detect odors from compounds emitted at the biorefinery. Further, odor detection is different for each individual, so the level of perception may differ by person. The odorous emissions from the biorefinery, if any, would be routine in the area since the biorefinery would operate 24 hours per day, 350 days per year.

As mentioned, DOE assumed in the calculation of odor concentrations that the proposed emission controls were in place and operational. Although these emissions controls are not designed for odor control but rather to reduce air quality impacts, the controls would be effective at odor control since they would reduce emissions of odorous compounds.

Feedstock fermentation and distillation would produce odorous volatile organic compounds including ethanol. The emissions from fermentation and distillation processes would be routed through wet scrubbers where ethanol would be collected to increase product yield. The wet scrubbers would reduce the amount of volatile organic compounds in the vent stream since they tend to be water soluble. According to the best available control technology analysis, the proposed wet scrubbers are typically 95- to more than 99-percent efficient at removing volatile organic compounds. Although the wet scrubbers would be used primarily to increase product yield, they would also reduce potential odors since they are effective at removing volatile organic compound emissions (Roach 2009r).

Ethanol, denatured ethanol, and denaturant would be stored onsite in storage tanks. These storage tanks would emit odorous volatile organic compounds and hazardous air pollutants. All storage tanks would be equipped with an internal floating roof and an external fixed roof. The internal roofs provide a low-profile secondary seal and would be in accordance with 40 CFR Part 60, Subpart Kb, "New Source Performance Standards." The internal floating roof was identified in the best available control technology analysis as the top control technology for volatile organic compound and hazardous air pollutant emission reduction that would result in a significant reduction of potential odors (Roach 2009r).

Odorous organic vapor emissions could also occur from equipment leaks. The most efficient control technology for controlling equipment leaks, as identified in the best available control technology, is a Leak Detection and Repair program in accordance with 40 CFR Part 60, Subpart VVa, "Standards of Performance for Equipment Leaks of VOC in the Synthetic Organic Chemicals Manufacturing Industry for which Construction, Reconstruction, or Modification Commenced After November 7, 2006." Creating and implementing such a program would reduce potential sources of odorous compounds at the biorefinery (Roach 2009r).

Another process that could be a source of odors is ethanol loadout. During loadout, the ethanol would be combined with natural gasoline (denaturant) and be transferred to tanker trucks and/or railcars for shipment. The emissions from the tanker truck and railcar loadout would be routed to a vapor recovery system that would result in approximately 98-percent control efficiency, thus reducing potential odorous emissions to negligible levels (ABHK 2009).

Odorous compounds would also be emitted during power generation. The byproducts of combustion, such as nitrogen dioxide, sulfur dioxide, acetaldehyde, and other hazardous air pollutants, would be the potential sources of odors. Bubbling fluidized bed combustion and good combustion practices would provide 90-percent control efficiency for odorous compounds (Salter 2009a). Nitrogen oxide emissions from the solid mass boilers would be reduced by utilizing a selective non-catalytic reduction system.

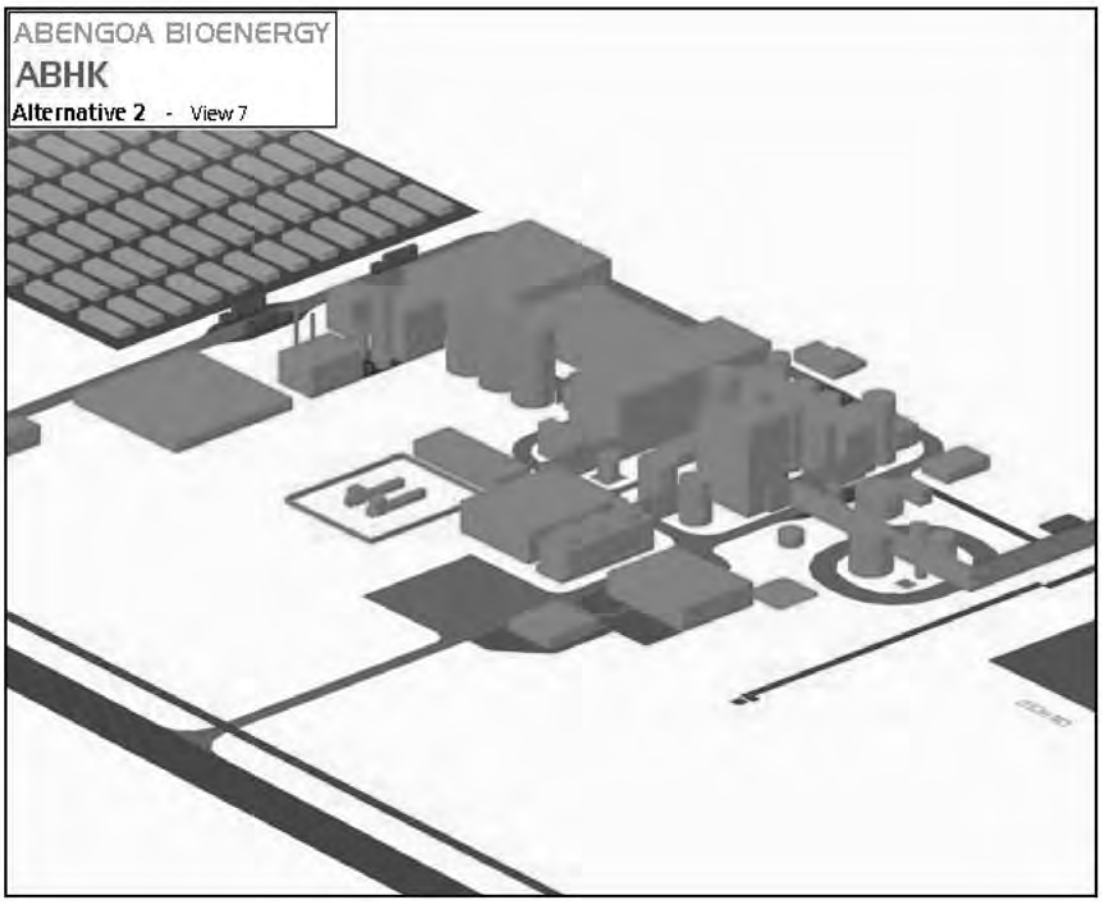
Most biomass to be processed at the biorefinery would be stored at seven offsite locations within 30 miles (48 kilometers) of the Biorefinery Project site. Since offsite storage of the biomass feedstock would be consistent with the current use of the land, new odors would not occur at these offsite storage locations. The 10-acre (0.04-square-kilometer) onsite biomass storage area would be consistent with the current use of the land as well as the 425-acre (1.7-square-kilometer) buffer area and surrounding agricultural areas; thus, no new odors would occur due to onsite storage of biomass.

4.8.2 ACTION ALTERNATIVE

4.8.2.1 Visual Resources

The Action Alternative would produce biofuel as in the Proposed Action; however, it would not produce any excess electricity that could be sold to the regional power grid. Because most of the processes would be the same between the Proposed Action and Action Alternative, most of the physical structures would be the same as well. The main difference with respect to visual resources is there would be fewer processes under the Action Alternative and, hence, structures than the Proposed Action.

Two of the major structure groups that would be smaller or not included under the Action Alternative are the group of structures that would comprise the biomass boiler operations and building that would contain the turbine. The Action Alternative would require only one smaller structure containing the biomass boiler and no building storing a turbine. These structures would appear similar to or smaller than grain storage silos and elevators at Cargill and Seaboard Farms to a viewer in Hugoton or at the golf course. Figure 4-13 shows a rendering of the biorefinery under the Action Alternative. The absence of the large structures that would comprise the biomass boiler operation is evident when comparing Figure 4-10 with Figure 4-13. In the rendering of the Proposed Action (Figure 4-10), the building containing the turbine is adjacent to and west of the boiler operations. While this building would not be as tall as the boiler operation structures, its absence in the rendering of the Action Alternative (Figure 4-13) is also noticeable. Since the Action Alternative would have fewer and smaller structures than in the Proposed Action, the visual impacts to the area caused by structures would be less.



Source: Roach 2009z.
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Figure 4-13. Rendering as seen from the northwest of the biorefinery under the Action Alternative.

Under the Action Alternative, the biorefinery would operate 24 hours a day, 350 days a year. Therefore, the Action Alternative would also use lighting that would be visible in the night sky, and the impacts from night lighting would be the same as those for the Proposed Action. To aid in mitigating impacts from night lighting at the biorefinery, downward-facing or directional light and the minimum amount of lighting needed for safe operation should be considered.

Because the biorefinery under the Action Alternative would not produce excess electricity that could be sold to the regional power grid, the 1.5-mile (2.4-kilometer)-long transmission line would not be built. Thus, the Action Alternative would not cause a visual impact from the addition of the transmission line.

4.8.2.2 Noise

4.8.2.2.1 *Impacts to Workers*

Under the Action Alternative, noise during construction would be generated from construction equipment. Typical noise levels at 50 feet (15 meters) are as follows: bulldozer (85 dBA), truck (88 dBA), front-loader (85 dBA), crane (83 to 88 dBA) (Hanson et al. 2006). All contractors would be required to comply with 29 CFR 1910.95 and use best management practices to limit construction noise as described in Chapter 6 of this EIS. Noise during construction would be the same as that for the Proposed Action and no noise impacts to workers are expected. Noise impacts to workers from biorefinery operations are expected to be similar to those at the facility in Ravenna, Nebraska, where a noise monitoring survey showed that the noise level in the majority of the facility was above 85 dBA and recommended that all persons entering the facility areas be required to wear hearing protection. Noise from operations under the Action Alternative would be the same as that described for the Proposed Action and would not cause hearing loss with proper hearing protection procedures and compliance with 29 CFR 1910.95.

4.8.2.2.2 *Impacts to the Public*

Short-term impacts during construction would be the same as those for the Proposed Action and would include noise from large machinery such as trucks, cranes, bulldozers, dumpers, front-loaders, and excavators. The combined sound level of three pieces of the loudest equipment (scraper, truck, and bulldozer) is 92 dBA measured at 50 feet (15 meters). This noise level would attenuate to approximately 56 dBA at the nearest receptor, a residence at the northwest property boundary located approximately 0.6 mile (1 kilometer) from the biorefinery construction site. This residence may experience some annoyance from construction noise. However, this noise would be temporary and only slightly higher than the EPA recommendation of an outdoor sound level of no more than 55 dBA for avoidance of annoyance (EPA 1978). Therefore, this impact would be small. However, the number of shipments by truck per day during construction would be 61 (Roach 2009j) [compared with 69 for the Proposed Action (Roach 2009a)], which equates to one truck-pass every 14 minutes for residences in the northwest corner of the city of Hugoton. Noise from truck traffic would be sufficient to interfere frequently with outdoor conversations and cause annoyance indoors.

Under the Action Alternative, at 0.6 mile (1 kilometer) and beyond, noise from operations would not be distinguishable from other background sources of noise. Similar to the Proposed Action, the day-night average sound level was calculated as 75 dBA at 50 feet (15 meters), which would attenuate to 39 dBA (below background) at approximately 0.6 mile. Therefore, it is expected that members of the public would not experience impacts from noise from biorefinery operations, as the noise-sensitive receptors (that is residences, schools, libraries, places of worship, and medical centers) are located at least 0.6 mile away.

The number of trucks per day during operations would be 53 (Roach 2009j), about a third of those for the Proposed Action. Trucks traveling along US-56 from the northeast would pass through a residential area in the northwest corner of the city of Hugoton. Assuming 50 percent of all trucks used this route, these residences would experience 27 truck passes between 7 a.m. and 9 p.m. This equates to approximately one truck every 31 minutes during this period. Typical noise levels for trucks at highway speed [approximately 55 miles per hour (89 kilometers per hour)] are approximately 90 dBA. Trucks passing through the city of Hugoton would be traveling at a lower speed, so lower noise levels would be typical, but would still be sufficient to interfere frequently with outdoor conversations and cause annoyance indoors.

Trucks traveling from the south and east along US-56/K-51 would pass through the southern part of the city of Hugoton. Noise-sensitive receptors along this route include the Stevens County Hospital, as well as several schools, residences, and places of worship. Assuming 20 percent of all trucks used this route, these receptors would experience 11 truck passes between 7 a.m. and 9 p.m. This equates to approximately one truck every 76 minutes during this period. These trucks would continue west on US-56/K-51 and likely travel north on Road 10 to Road P to access the Biorefinery Project site and, thus, would pass by the residence at the northwest boundary of the Project site. In addition, trucks traveling from the south and west on US-56/K-51 would likely travel north on Road 10 to Road P, and trucks traveling from the north and west on Road P would also pass by this residence. Assuming 25 percent of all trucks traveled from the south and west and 5 percent of all trucks traveled from the north and west, this residence would experience 50 percent of the total truck traffic, or a total of 27 truck passes between 7 a.m. and 9 p.m. This equates to approximately one truck every 31 minutes during this period. Most of the trucks passing by this residence would be turning and thus traveling at a lower speed, with lower noise levels, but would still be sufficient to interfere frequently with outdoor conversations and cause annoyance indoors. Table 4-39 summarizes the number of truck passes along various potential transportation routes under the Action Alternative.

Table 4-39. Truck traffic along various transportation routes to the Project site during operations under the Action Alternative.

Route to biorefinery	Noise-sensitive receptors along route	Percent of trucks assumed to use this route	Number of trucks per day	Elapsed time between truck passes (minutes)
From north and east via US-56 to Road P	Residential area in northwest corner of city of Hugoton	50	27	31
From north and west on Road P	Residence at northwest property boundary of the Project site	5	3	280
From south and west on US-56/K-51[a]	None	25	13	65
From south and east on US-56/K-51[a]	Stevens County Hospital, several residences, schools, and places of worship	20	11	76

a. Trucks using these routes would likely travel north on Road 10 to Road P to access the biorefinery. Therefore, 27 trucks per day would travel Road P and pass by the residence at the northwest boundary of the Project site. This equates to 1 truck pass every 31 minutes.

Under the Action Alternative, noise from construction, biorefinery operations, and rail traffic would be the same as that described for the Proposed Action. However, the frequency of noise from truck traffic during construction would be slightly less than for the Proposed Action, and the frequency of noise from truck traffic during operations from the Action Alternative would be about a third of that for the Proposed Action.

4.8.2.3 Odor

Under the Action Alternative, the biorefinery would produce a smaller amount of denatured ethanol than under the Proposed Action; therefore, the potential amount of odorous emissions produced by ethanol production processes, such as fermentation and ethanol storage, would be less. Also, under the Action Alternative, the biorefinery would not provide electricity to the regional power grid. Only enough power would be generated to operate the biorefinery. Because of the reduction in power generation under the Action Alternative, Abengoa Bioenergy would use only one smaller solids boiler, compared with the two larger boilers under the Proposed Action. Because there would be only one boiler and it would be smaller, the emissions from the power generation source group (Table 4-2) under the Action Alternative would decrease. Under the Action Alternative, potential emissions of odorous volatile organic compounds and hazardous air pollutants from the boiler would be less than the equivalent emissions under the Proposed Action; nitrogen oxide emissions from the boiler under the Action Alternative would be 32 percent of those under the Proposed Action; and sulfur dioxide boiler emissions would be 28 percent of the Proposed Action emissions (Roach 2009e). Because the overall odorous emissions of the Action Alternative would be less than or equal to the Proposed Action, a modeling analysis of the Action Alternative was not conducted, as DOE anticipates that the concentrations of odorous compounds emitted by the Action Alternative would be below the detection threshold levels at the golf course, industrial park, or in the city of Hugoton.

4.8.3 SUMMARY OF AESTHETICS IMPACTS

4.8.3.1 Visual Resources

Because new structures would be built under the Proposed Action and Action Alternative, the views from various vantage points in the surrounding area, such as the city of Hugoton and the Forewinds Golf Course, would change. However, structures in the biorefinery under both action alternatives would be visually similar to the grain silos, chemical tanks, and other structures located adjacent to the biorefinery parcel. Thus, the Proposed Action would result in additional but similar structures visible from surrounding vantage points, such as the city of Hugoton and the golf course. The biorefinery under the Proposed Action would have more structures, and hence, more of a visual impact than under the Action Alternative.

Both the Proposed Action and Action Alternative would be a source of night lighting noticeable to viewers from the city of Hugoton, as the biorefinery would operate 24 hours a day, 350 days a year. The use of downward-facing or directional lighting and the minimum amount of lighting needed for safe operation would aid in mitigating impacts from night lighting. Additional night lighting at the biorefinery under both action alternatives might be noticeable to viewers in the city of Hugoton but would be similar to night lighting at the Hugoton Municipal Airport, which is near the Biorefinery Project site.

Both the Proposed Action and Action Alternative would utilize offsite storage locations that would not be in visual contrast to the surrounding agricultural areas. Further, the buffer area (to the east of the biorefinery parcel) would still be used for agricultural purposes; therefore, visual impacts would not occur due to activities on the buffer area. Lastly, the Proposed Action, but not the Action Alternative, would require erecting and using a new 1.5-mile (2.4-kilometer)-long transmission line. This transmission line would span a major distance along the horizon. However, the line would not be a large, solid structure blocking the line-of-sight for viewers from a distance; that is, viewers in the city of Hugoton or the Forewinds Golf Course. Impacts from the transmission line would be greater to viewers in the near distance; that is, the structure would be more visible from Road P and Road 11 near the Biorefinery Project site.

4.8.3.2 Noise

Under the Proposed Action, workers would be exposed to noise during construction from construction equipment. Best management practices would be employed to limit construction noise and contractors would comply with 29 CFR 1910.95; therefore, no hearing loss is expected. Workers would also be exposed to noise during operations. However, hearing loss would not occur with proper hearing protection and compliance with 29 CFR 1910.95.

The nearest residence, approximately 0.6 mile (1 kilometer) away, may experience some annoyance from the construction noise but the impact would be small due to the magnitude of the noise, approximately 56 dBA, and due to the temporary nature of construction noise. Noise and sound levels would be typical of new construction activity and would be lessened with best management practices. Noise from biorefinery operations would attenuate to below background levels at the nearest residence, school, library, place of worship, and medical center and, therefore, no impacts to the members of the public from biorefinery operations would occur. During construction, a residential area in the northwest corner of Hugoton would experience noise from trucks traveling to the biorefinery about every 12 minutes. During biorefinery operations, this residential area, as well as the residence at the northwest property boundary, the Stevens County Hospital, and several schools and places of worship along US-56/K-51 would experience noise impacts from truck traffic. Trucks carrying shipments to the biorefinery would pass some residences in Hugoton and the residence at the northwest property boundary about every 9.5 minutes and would pass the Stevens County Hospital, several schools, residences, and places of worship along US-56/K-51 about every 24 minutes. Noise from these passing trucks would interfere with outdoor conversations and cause annoyance indoors.

Under the Action Alternative, workers would be exposed to noise during construction from construction equipment. Best management practices would be employed to limit construction noise, and contractors would comply with 29 CFR 1910.95; therefore, no hearing loss is expected. Workers would also be exposed to noise during operations. However, hearing loss would not occur with proper hearing protection and compliance with 29 CFR 1910.95.

The nearest residence, approximately 0.6 mile (1 kilometer) away, may experience some annoyance from the construction noise, but the impact would be small due to the magnitude of the noise, approximately 56 dBA, and due to the temporary nature of construction noise. Noise and sound levels would be typical of new construction activity and would be lessened with best management practices. Noise from biorefinery operations would attenuate to below background levels at the nearest residence, school, library, place of worship, and medical center and, therefore, no impacts to the members of the public from biorefinery operations would occur. During construction, a residential area in the northwest corner of Hugoton would experience noise from trucks traveling to the biorefinery about every 14 minutes. During biorefinery operations, this residential area, as well as the residence at the northwest property boundary, the Stevens County Hospital, and several schools and places of worship along US-56/K-51 would experience noise impacts from truck traffic. Trucks carrying shipments to the biorefinery would pass some residences in Hugoton and the residence at the northwest property boundary about every 31 minutes, and would pass the Stevens County Hospital, several schools, residences, and places of worship along US-56/K-51 about every 76 minutes. Noise from these passing trucks would interfere with outdoor conversations and cause annoyance indoors

4.8.3.3 Odor

Both the Proposed Action and Action Alternative would be sources of odorous emissions. To analyze the Proposed Action, DOE used an air dispersion model to estimate concentrations of odorous compounds based on the April 2009 biorefinery design. The maximum modeled concentrations at the biorefinery parcel fence line and, if necessary, at other offsite receptor locations were compared with their respective odor threshold concentration values. Although the results of the modeling analysis demonstrated that one odorous compound (nitrogen dioxide) might be detectable at the fence line, none of the modeled concentrations exceeded the odor threshold values offsite where the public would commonly be located. Therefore, DOE anticipates that, based on the results of the modeling analysis, odors generated by the Proposed Action should not be detectable offsite. Because the odorous emissions from the Action Alternative would be less than the odorous emissions of the Proposed Action, DOE anticipates that concentrations of odorous compounds from the Action Alternative would be below the detection threshold values offsite. Emission controls, primarily used for reducing air quality impacts, would also reduce the amount of odorous emissions from both the Proposed Action and Action Alternative.

4.9 Socioeconomics

Any influx of capital (spending) or employment opportunities, such as a large construction project, to a region will impact the existing socioeconomic environment to some degree. Socioeconomic variables include population and housing, employment and income, education, and public services (law enforcement, fire protection, and medical services). These variables are interrelated in their response to changes in the environment. This section describes the potential effects of construction and operation of the biorefinery in Hugoton, Kansas, on the existing environment of the socioeconomic region of influence. As Chapter 3, Section 3.10 describes, the socioeconomic region of influence consists of Morton, Seward, and Stevens counties in Kansas and Texas County in Oklahoma.

4.9.1 PROPOSED ACTION

Socioeconomic impacts can be addressed in terms of both *direct* and *indirect* impacts. Direct impacts are those changes that are directly attributed to the Proposed Action, such as changes in employment, population, or spending (income or earnings) resulting from the construction and operation of the biorefinery. Indirect impacts in the region of influence occur as a reaction to project-induced changes in employment and regional expenditures. Changes in regional expenditures can occur because of changes in employment levels and the resulting changes in wage income. Changes in regional expenditures also occur from the demand for materials and services associated with operations and maintenance of a facility. Socioeconomic impacts are the sum of the direct and indirect impacts.

The direct impacts estimated in this socioeconomic analysis are based on project summary data developed by Abengoa Bioenergy. The Regional Input-Output Modeling System multipliers (RIMS II) that were developed specifically for the biorefinery estimated impacts for total employment and total earnings (direct and indirect). The multipliers are specific to the region of influence and the workforce characteristics of the Abengoa Biorefinery Project. The in-migration of workers during construction and operations would create indirect jobs and increased spending in the area because of the *multiplier effect*. Under the multiplier effect, each dollar spent on goods and services by an in-migrant becomes income to the recipient, who saves a portion but re-spends the rest. In turn, this re-spending becomes income to someone else, who in turn saves part and re-spends the rest. The multiplier is the number of times the final increase in consumption exceeds the initial dollar spent. The U.S. Department of Commerce, Bureau of Economic Analysis, Economics and Statistics Division, calculated the multipliers for jobs and earnings for the biorefinery. The RIMS II economic model incorporates buying and selling linkages among regional industries and provides multipliers by industry sector to estimate the impacts of changes in that sector to a regional economy. This EIS uses the detailed employment multipliers for both the construction and utilities industries to estimate the number of indirect jobs and the impact of biorefinery-related expenditures in the region of influence. The Bureau of Economic Analysis does not yet recognize the “biorefinery” industry so the utility industry was used as a proxy industry. The region of influence has a well-developed utilities industry, and worker characteristics, including salaries and educational levels, in that industry are comparable to the anticipated characteristics of operations workers at the biorefinery.

Abengoa Bioenergy provided estimates of directly employed construction and operations workforces and durations of each phase (Roach 2008e, 2008f). The overall construction workforce would reach a peak of 250 construction workers and 6 operations workers during week 46 of construction. The most intense period of construction would last approximately 6 months and would average about 200 construction workers and 22 operations workers. Once the biorefinery was fully staffed and operational, the estimate for the operations workforce is 43 positions. This EIS evaluates the socioeconomic impacts on employment and income for the construction and operations phases. The EIS also discusses other impacted systems, including housing and taxes, and other areas that vary with changes in regional employment and income, including education and public services (that is, law enforcement, fire protection, and medical services). The EIS analysis of the construction phase is for the peak construction period (the period during which the greatest number of workers are expected onsite) which bounds the analysis. The operations phase would be expected to remain constant at 43 positions for the operational life of the biorefinery, estimated to be at least 30 years.

4.9.1.1 Impacts to Socioeconomic Variables During Construction

Under the Proposed Action, the direct construction costs would be $300 million (including worker wages during construction). Construction would be completed in approximately 18 months. The project would gradually employ a construction workforce of up to 256 workers during the period of peak construction activity. The creation of new direct jobs (190) in Stevens County and the associated new income would create 88 indirect jobs, for a total of 280 new jobs throughout the region of influence. Table 4-40 presents information about the number of direct workers and change in population in the region of influence during peak construction as a result of the Proposed Action.

Table 4-40. Workforce migration and family composition characteristics during peak construction.

Description	Construction workers	Operations workers	Workforce during construction
Workforce characterization			
Number of workers employed during peak construction period (Week 46)[a]	250	6	256
Workforce migration			
Percent of workforce migrating into region of influence	75%	25%	NA
Total number of workers migrating into region of influence during peak construction period	188	2	190
Families			
Percent of in-migrating workers who bring families	70%	100%	NA
Percent of workers who do not bring families	30%	0%	
Number of in-migrating workers who bring families into region of influence	132	2	134
Number of in-migrating workers who do not bring families into region of influence	56	0	56
Average worker family size (worker, spouse, children)	3.25[b]	3.25[b]	NA
Total in-migration – families and unaccompanied workers			
Total number of workers who bring families migrating into the region of influence (= total families)	132	2	134
In-migrating workers' family members	297	5	302
Total in-migrating workers with families, plus family members	429	7	436
Total number of workers not bringing families into the region of influence	56	0	56
Total number of workers and family members migrating into the region of influence	485	7	492
School-age children			
Average number of school-age children per family[c]	0.8	0.8	NA
Total number of school-age children in-migrating to the region of influence	106	6	112

a. Source: Roach 2008e.
b. Source: USCB 2000.
c. Source: Malhotra and Manninen 1981.
NA = not applicable.

4.9.1.2 Impacts to Population and Housing During Construction

The Proposed Action would require 250 construction workers at the peak period of construction. The Proposed Action would require, on average, approximately 200 construction workers during the period of most intense construction activity, a duration of 6 months (months 12 through 17). Because the existing labor pool, and specifically the construction labor pool, as measured by 2006 employment in the region of influence, is too small to fill the positions that would be created for the construction of biorefinery (Chapter 3, Table 3-24), it estimated that 188 of the peak requirement of 250 construction positions would likely be filled by workers from outside the region of influence. These workers would be expected to migrate, temporarily, into the region to fill positions. During the peak period of construction, six operations workers would also be employed. Two of the six operations workers would also be expected to in-migrate to the region. In 2007, there were 23,784 individuals in the labor force in the region of influence (Chapter 3, Table 3-26). There has been little new construction in Morton or Seward counties in Kansas, or Texas County in Oklahoma recently, and hence, there is a very small construction-worker presence; the U.S. Bureau of Economic Analysis did not disclose the employment numbers for construction sector employment for those counties. The Bureau of Economic Analysis also did not disclose employment numbers for the utilities industry (from which the operations workers transferred) for Morton, Seward, and Stevens counties. Ninety-three employees in Texas County are in the utilities industry (Chapter 3, Table 3-24).

Approximately 0.26 percent of the individuals currently in the region’s general labor force, or 62 people, could be expected to be available for new construction work employment opportunities and 4 people could be expected to be available for operations positions. The 66 workers already residing in the region of influence could be expected to accept positions with the biorefinery project. An additional 190 workers (that is, 188 construction workers and 2 operations workers employed during construction) would be expected to migrate into the region of influence to accept biorefinery assignments.

Some of these in-migrating workers would bring families. The region of influence could experience a project-induced population increase, temporarily and during the peak period of construction activity, of approximately 492 persons (485 from construction workers and families and 7 from operations workers and families). Approximately 70 percent of the 188 in-migrating construction workers and 100 percent of the 2 in-migrating operations workers during peak construction would be expected to bring families (134 workers), and each of those family units would have a total of 3.25 members (134 workers × 3.25 average family size = 436 person increase). Further, approximately 56 construction workers would be expected to migrate into the region of influence without family members. Predicting residential distribution patterns within the region of influence of in-migrating workers is not feasible. However, in 2007, 60 percent of the region’s population lived in two cities in the region of influence, Liberal, Kansas, and Guymon, Oklahoma, (USCB 2008b). Collectively, the four population centers (the largest city in each of the four counties) housed approximately 70 percent of the region’s estimated population in 2007.

All in-migrating workers would require housing. Workers currently residing in the region of influence would be expected to already be housed. Construction workers, because of the short duration of job assignments, often elect temporary housing, such as rental units, short-term hotel/motel leases, or mobile homes (including worker-transported recreational vehicle units) to provide flexibility. Operations workers would be likely to seek more permanent housing. Of the housing units in the region of influence 2000 inventory, there were 1,959 vacant housing units (9.9 percent of the inventory). The U.S. Census Bureau estimates that less than 130 additional units have been added to the inventory since 2002 (25 in Morton County, 32 in Seward County, a loss of 1 unit in Stevens County, and 73 additional units in Texas County) (USCB 2007a). Because (1) the region of influence has so much available housing, (2) the population in the region of influence is near the 2000 levels when there was a nearly 10-percent vacancy rate in housing units, (3) the short duration of the construction phase of this project, and (4) the established preference for temporary housing (rental units, hotel/motels, and recreational vehicle accommodations) among construction workers with a short assignment, in-migrating workers are unlikely to exert pressure for new residential construction. It is unlikely that housing prices and/or contractual rental rates would experience meaningful upward pressure from the increased demand. Little new residential construction would be expected as a result of project-induced increases in population during construction. Impacts to housing, therefore, would be small, and temporary. The addition of 485 people from the influx of construction workers to the region of influence would represent an increase of 0.96 percent over the estimated 2007 population, a small and temporary increase. The addition of seven people from the influx of operations workers during construction would represent a very small increase over the 2007 baseline population.

4.9.1.3 Impacts to Employment and Income During Construction

The average annual wage of a worker in the region of influence in 2006 ranged from $28,560 to $32,345 (BEA 2008a). Abengoa Bioenergy estimates the 2008 average annual wage of a unionized construction worker in Stevens County is $61,942 (Roach 2009bb), while non-union construction worker wage is approximately $55,748 (Roach 2009cc). This EIS assumes an average annual construction worker base wage of $62,000. The Proposed Action would result in approximately $12 million indirect worker wages in the year of most intense construction activity if an average of about 200 construction workers and 22 operations workers were employed for 6 months and 160 construction workers and 5 operations workers were employed for the remaining 6 months. The resulting impact to the region, after application of the earnings multiplier, would be an infusion of $16.6 million to the economy during the peak year of construction. The 2006 per capita income in the region of influence was $28,020. The infusion of $16.6 million (after the earnings multiplier is applied) could represent a 1.1-percent increase in 2006 per capita income.

Estimates of the current Gross Domestic Product by county are not available and, because the region of influence boundary extends over a two-state area and the amount of the direct and indirect wages that would be spent in each state is not known, the percent impact of the increased spending in the region of influence was not estimated. In 2007, however, the Kansas Gross Domestic Product was approximately $117 million and the Oklahoma Gross Domestic Product was approximately $139 million (BEA 2008b). Abengoa Biorefinery has not committed to spending a specific portion of construction dollars in the region of influence (Roach 2009x).

Annualized unemployment rates in 2008 in the region of influence ranged from 2.7 percent in Texas County to 3.3 percent in Stevens County (BLS 2009). The relatively low unemployment rate in the region of influence suggests that area employers do not have a pool of potential workers to choose from in filling permanent or temporary positions and are, therefore, likely to be reliant on in-migrating workers to fill most new positions. Construction, by its very nature, employs workers on a temporary basis; therefore, once a facility is completed or a specific job assignment is completed, workers must find new jobs. Often workers move into an area on a temporary basis and then migrate out of the area when the construction assignment is completed. Abengoa Bioenergy expects this to be the case for the construction of the biorefinery. As displayed in Table 3-26 in Chapter 3, in 2007, the labor force in the region of influence consisted of 23,784 individuals. The labor force includes employed and unemployed individuals. The 250 directly employed construction workers needed at the peak period for biorefinery construction would represent slightly more than 1 percent of the existing labor force and an undetermined, but very large, percentage of the existing construction workforce. As discussed in Chapter 3, the number of workers employed in the construction industry was not disclosed by the Bureau of Economic Analysis in three of the four counties in the region of influence. However, because so little construction activity has occurred recently in the region of influence, the industry employment can reasonably be assumed to be very small. Thus, employment demands of the biorefinery would be a strain on the existing construction sector labor pool. The six directly employed operations workers at the peak period during construction would represent 0.03 percent of the labor force, and a small, but undetermined percentage of the existing utilities workforce. As discussed in Chapter 3, the Bureau of Economic Analysis did not disclose the number of workers employed in the utilities industry for three of the four counties in the region of influence. Generally, if a project needs to tap more than 5 percent of an existing sector's employment pool, workers are sought from outside the region.

It is likely that approximately 188 construction workers and 2 operations workers from outside the region of influence would migrate into the region to fulfill the project's need for workers during the construction peak period. Some workers currently working in the region of influence in a different industry would be attracted to the biorefinery because the estimated wages of construction workers is approximately twice the area's average wage and operations worker wages are more than 50 percent greater than the area's average wage (see Section 3.10). In addition, some unemployed individuals would be expected to accept positions with the biorefinery's workforce.

In addition to the jobs directly associated with the construction of the biorefinery, 88 indirect jobs would be created during the peak period of construction. Indirect jobs are created by directly employed project workers spending their wages and by the expenditures related to the purchase of materials and services as a facility is being built. Indirect jobs are generally not highly specialized in nature and are often found in the retail and service sectors. The indirect jobs would likely be filled by residents of the region of influence, including some who may be currently unemployed, and by adult family members of in-migrating workers during construction. Table 4-41 presents information about changes in direct and indirect employment in the region of influence as a result of the Proposed Action. It is unlikely that the indirect jobs would be filled by individuals moving into the region of influence specifically to assume the newly created indirect positions. The existing labor pool is of sufficient size to fill the positions. Thus, there would be no induced population increase in the region of influence as a result of the newly created indirect jobs. Because the peak construction period would be temporary and of short duration, many of the indirect jobs created during construction would also be of a temporary nature. Some indirect jobs created during construction would carry forward to service operations workers, but many would dissolve as construction workers departed the region of influence when assignments were completed.

During the 12-month period of most intense construction activity, the region could experience an almost $17 million infusion of earnings. Local and state governments would benefit from this increased earnings and subsequent spending, in terms of revenue collected from various tax streams. As discussed in Chapter 3, Section 3.10.2.2, jurisdictions within the region of influence have several taxing avenues from which to collect project-induced direct revenues (for example, state and local sales taxes, personal and corporate income taxes, and real and personal property taxes). Abengoa Bioenergy would not be subject to corporate income tax obligations during the construction phase (because the biorefinery would not yet generate income), but retail businesses that provide goods or services to workers and their families would pay corporate taxes (if the entity were incorporated). It is not possible to determine the amount of revenue each jurisdiction would capture in taxes because wages and income could be spent in many locales, both inside and outside the region of influence. In addition, the portion of earnings that would become taxable income is not known. However, the U.S. Bureau of Economic Analysis has estimated that every $100 earned by a construction worker in a newly created position would generate an additional $36.69 in earnings to someone else, and every $100 earned by an operations worker in a newly created position would generate $121.59 in earnings to someone else (BEA 2006). The materials and services used in constructing the biorefinery, such as stainless steel and concrete, are likely to be purchased outside the region of influence. Section 4.5 of this EIS discusses impacts associated with construction materials.

Table 4-41. Changes in direct and indirect employment during the construction phase.

Direct and indirect jobs	Construction	Operations	Total
Workforce during peak construction (week 46)	250	6	256
Number of workers in- migrating to ROI during construction	188	2	190
RIMS II employment multiplier (indirect portion only)[a]	0.4434	2.1111	NA
Indirect jobs resulting from in-migrating workers	84	4	88
Number of unemployed persons in the ROI labor force, 2008[b]	717	717	717
Estimated number of unemployed persons available to fill indirect jobs (20% of unemployed persons)	143	143	143
Number of working-age adults accompanying in-migrating workers (assuming 1 other adult per worker)	188	2	190
Percent of working-age adults accompanying in-migrating workers during operations available to work[c]	52%	52%	52%
Number of working-age adults accompanying in migrating workers with families available to work	98	1	99
Number of adults available to fill indirect jobs (unemployed individuals and adults accompanying in-migrating workers) available for work	241	144	242[d]
Indirect jobs that need to be filled by adults currently residing outside of 50-mile (80-kilometer) ROI	0	0	0

a. Source: BEA 2006.
b. Source: BLS 2009.
c. Source: USCB 2007b.
d. The number of unemployed individuals in the ROI assumed to be available for work is 20 percent of 717 unemployed workers. This same pool of workers is for both construction indirect jobs and operations indirect jobs; therefore, the total number of individuals available to fill indirect jobs is 242.
NA = not applicable.
ROI = region of influence.

Unemployment likely would rise slightly in the region of influence at the end of the construction phase with the reduced job opportunities for previously employed construction workers. As construction workers would leave the region and other nonproject-related employment opportunities developed, including employment opportunities associated with biorefinery operations, the unemployment rate would be expected to decrease and then stabilize. Operations workers employed during construction would be expected to remain employed and not leave the region at construction conclusion.

4.9.1.4 Impacts to Socioeconomic Variables During Operations

The completed biorefinery is scheduled to be in service for at least 30 years. When fully staffed, the biorefinery would employ a total of 43 workers in Stevens County. Approximately 75 percent of all direct jobs created for the biorefinery operations likely would be filled from the labor pool within the region of influence at the completion of construction. The region's labor pool would have grown as a result of projected, nonproject-related population increases and as a result of project construction activities. Although most employment associated with the construction phase of the project would cease to exist once construction had completed, some of those previously employed construction workers would remain in the region and be able to fill operations positions. The new jobs would be broadly classified as being in the utility industry. Some workers, and their families, who moved into the region of influence to fill employment opportunities during the construction phase would move out of the region of influence once construction had ended, leaving the utilization of community services, including public education, at levels similar to preconstruction levels.

The 43 operations jobs represent 0.18 percent of the region of influence employment base in 2007. Twenty-three indirect jobs would be created during the operations phase. Some of the indirect positions created during the construction phase would remain as a result of operations worker wages being spent in the region and of expenditures for materials and services associated with biorefinery operations. Because the operations workforce would be substantially smaller than the construction workforce, and because annual operations and maintenance expenditures would be less than annualized expenditures during construction, fewer indirect jobs would be needed to support project-related spending. Table 4-42 summarizes assumptions used in this analysis of impacts to socioeconomic variables in the region of influence during operations.

Table 4-42. Assumptions of workforce migration and family composition characteristics during the operations phase.

Description	Operations phase
Workforce characterization	
Number of workers during the operations phase[a]	43
Workforce migration	
Percent of operations workforce migrating into region of influence	25%
Number of operations workers migrating into region of influence during the operations phase	11
Families	
Percent of in-migrating workers who bring families	100%
Number of in-migrating workers who bring families into region of influence	11
Average worker family size (worker, spouse, children)	3.25[b]
Total in-migration – families and workers	
Number of in-migrating operations workers	11
In-migrating workers family members	24
Total in-migrating induced population increase in region of influence	35
School-age children	
Number of school-age children per family[c]	0.8
Total number of school-age children in-migrating during operations	9

a. Source: Roach 2008e.
b. Source: USCB 2000.
c. Source: Malhotra and Manninen 1981.

4.9.1.5 Impacts to Population and Housing During Operations

Biorefinery operations would require approximately 43 workers. Although the existing workforce employed in the manufacturing and utility sectors (those sectors most closely associated with attributes of the emerging biorefinery industry) in the region of influence is too small to fill the required operations positions, some construction workers and adult family members who migrated into the region of influence during the construction phase, operations workers hired during construction, coupled with current residents who are part of the existing general labor pool, would be able to fill the approximately 75 percent of the newly created operations positions. The project-induced population growth during operations, arising from the 11 operations workers and their family members who would migrate into the area, would be 35 persons, approximately 0.07 percent of the region of influence's 2007 estimated population. In addition, because of the relatively large vacant housing inventory in the region of influence and the vacancies that would be created by the departing construction workforce, there would be no additional strain on the housing market. Because many of the individuals likely to assume operations positions would already reside in the region of influence and already be housed, there would be no major influx of workers to fill the operations positions that would require housing, and, therefore, there would be no need for new residential construction. However, because operations positions are permanent in nature, as opposed to construction positions which are temporary, operations workers would be more likely to select owner-occupied units and higher-priced units than construction workers, so the dynamics of the housing market would shift slightly. Predicting residential distribution patterns of operations workers beyond the regional level is not feasible. However, in 2007, 60 percent of the region of influence population lived in the two largest cities in the region of influence, Liberal, Kansas, and Guymon, Oklahoma (USCB 2008b). Similar to the construction workers, a large portion of the operations workforce would be expected to reside in Liberal and Guymon because of the cities' proximity to the biorefinery, the readily available housing, and the presence of community services such as medical services and educational facilities. Although 11 operations workers who would require housing are expected to migrate to the region of influence to assume operations positions, the impact on the 2007 housing inventory of 20,270 units would be very small, less than 0.05 percent. There is unlikely to be project-induced market pressure during operations that would affect housing prices or contractual rental prices. Little new residential construction would be expected. Table 4-43 presents information about the characteristics of the operations workforce.

4.9.1.6 Impacts to Employment and Income During Operations

The population in the region of influence is projected to grow relatively slowly for the next several decades. The 2010 population is projected to be 5.5 percent higher than in 2000, and the 2020 population is expected to be approximately 11 percent higher than in 2010 (Chapter 3, Table 3-22). The region of influence's labor force, which has stabilized recently, would grow to about 24,000 by 2010. By 2020, the four-county region of influence would have a labor force of approximately 26,424 individuals if it grew at the same rate the population is projected to grow in that decade (Chapter 3, Table 3-22). An operations workforce of 43 workers, earning an average salary of $46,628, would result in an annual project-induced infusion of approximately $4.4 million in the region of influence (after application of the earnings multiplier). The $4.4 million represent an increase of $87 per capita (0.31 percent) of the estimated 2006 per capita income in the region of influence, $28,020 (Chapter 3, Table 3-27). Twenty-three indirect jobs are expected to be created during the operations phase (BEA 2006). Some of the indirect jobs created during construction would dissolve, but others would transition to support the operations workers. These jobs would likely be filled by many of the same workers who occupied similar positions during the construction phase, when 88 indirect jobs had been created; there would be no population influx to the region of influence as a result of the indirect jobs. All indirect jobs would likely be filled by currently employed or unemployed residents of the region of influence including those who held indirect positions created during construction, or by adult family members of in-migrating operations workers. Table 4-43 summarizes changes in direct and indirect employment in the region of influence as a result of project-induced opportunities.

Table 4-43. Changes in direct and indirect employment during the operations phase.

Demographics	Operations phase
Operations workforce	43
Number of operations workers in- migrating to region of influence (25% of operations workforce)	11
Indirect jobs resulting from in-migrating operations workers [a] (11 × 2.1111)	23
Number of unemployed persons in the ROI labor force, 2008	717
Estimated number of unemployed persons available to fill indirect jobs (20% of unemployed persons)	143
Number of working-age adults accompanying in-migrating workers during operations who bring families (assuming 1 other adult per worker)	11
Percent of working-age adults accompanying in-migrating workers during operations available to work[b]	52%
Number of working-age adults accompanying in migrating workers with families available to work	6
Number of adults available to fill indirect jobs (unemployed individuals and adults accompanying in-migrating workers)	149
Indirect jobs that need to be filled by adults currently residing outside of 50-mile (80-kilometer) radius	0

a. Source: BEA 2006.
b. Source: USCB 2007b.

During biorefinery operations, the region could experience an annual $4.4 million infusion of earnings. The biorefinery is expected to be operational for at least 30 years. Local and state governments would benefit from this increased earnings, and subsequent spending, in terms of revenue collected from various tax streams. As discussed in Chapter 3, Section 3.10.2.2, jurisdictions within the region of influence have several taxing avenues from which to collect project-induced direct revenues (for example, state and local sales taxes, personal and corporate income taxes, real and personal property taxes). Abengoa Bioenergy would be expected to pay annual corporate income tax obligations during the operational life of the biorefinery, although the amount of income taxes due cannot be determined at this time. In addition, retail businesses that provide goods or services to workers and their families would pay corporate taxes (if the entity were incorporated). It is not possible to determine the amount of revenue each jurisdiction would capture in taxes because wages and income could be spent in many locales, both inside and outside the region of influence. Further, the portion of earnings that would become taxable income is not known. However, the U.S. Bureau of Economic Analysis estimated that every $100 earned by an operations worker in a newly created position would generate an additional $121.59 in earnings to someone else. Annual wages paid to directly employed biorefinery employees would be approximately $2 million (in 2009 dollars). Because the region of influence is so rural in nature, and no city within the region of influence is a major retail center, a large portion of the earnings of the direct and indirect persons could be spent outside of the region of influence.

4.9.1.7 Community Services

Any influx of capital (spending) or employment, such as a large construction project, to a region will impact the existing socioeconomic environment and the community services within that environment.

Community services include education and public services (such as law enforcement, fire protection, and medical services). These community services are interrelated in their response to changes in a region's population. This section describes the potential effects of the construction and operations phases of the biorefinery on the existing community services of the socioeconomic region of influence. The project-induced, temporary population increase during the construction phase would impact community services in the region of influence. The influx of operations population would not meaningfully alter the current level of public services in the region of influence.

4.9.1.7.1 *Impacts on Community Services During Construction and Operations*

Impacts to community services can be addressed in terms of changes to a region's population and subsequent demand for community services. Community services include education and public services (law enforcement, fire protection, and medical services).

Abengoa Bioenergy provided estimates of construction and operations workforces and durations period of each phase (Roach 2008e, 2008f). Assumptions used for these determinations are summarized in Tables 4-40 through Table 4-43. The impacts on community services are evaluated during the two phases of the project: construction and operations. The construction phase is analyzed for the peak construction phase, which bounds the analysis. The operations phase is analyzed at the expected full staffing level of the biorefinery.

4.9.1.7.2 *Impacts to Education During Construction*

Approximately 70 percent of the in-migrating construction workers (approximately 188 workers) and 100 percent of the operations workers (2 workers) during construction would be expected to bring a family into the region of influence. Each in-migrating worker bringing a family would have an average of 0.8 school-aged children. The project-induced increase of school-aged children would be 112 students. The school districts in the region of influence enrolled 10,713 students in the 2005/2006 school year. The addition of 112 school-aged children represents a small impact, approximately 1.3 percent of the 2005/2006 school year enrollment. As discussed in Chapter 3, Section 3.10.2.4.1, the states of Kansas and Oklahoma have school funding equalization programs that strive to ensure that the local school districts would not be unduly burdened to provide educational services to the children of in-migrating workers without additional funding. There are three post-secondary institutions within a 50-mile (80-kilometer) radius of the Biorefinery Project site. These institutions would be able to absorb any increased enrollment that may result from the in-migrating adult population seeking collegiate education or training.

4.9.1.7.3 *Impacts to Public Services (law enforcement, fire protection, and medical services) During Construction*

Existing public services, including law enforcement, fire protection, and medical services, would not be significantly affected since some of the construction workers already live within the region of influence, and the influx of workers and family members from outside the region of influence would be of short duration. The project-induced increase in population, approximately 492 individuals, would have a small impact on the current residents-to-sworn officer and residents-to-active firefighter ratios in the region of influence. The current residents-to-sworn law enforcement officer ratio is 1,423-to-1; with the expected project-induced population increase, the ratio would increase to 1,437-to-1 if there were no change in staffing levels, a less than 1-percent increase. The current residents-to-active firefighter is 285-to-1; with the expected project-induced population increase, the ratio would increase to 287-to-1 if there were no change in staffing level, a less than 1-percent increase. The 2007 residents-to-staffed hospital beds ratio is 397-to-1; with the expected project-induced population increase, the ratio would increase to 401-to-1, again, a less than 1-percent increase.

Local governments may elect to increase the number of law enforcement officers and the number of active firefighters to preserve preconstruction ratios. Because of the inherent delay in the availability of local tax dollars (local sales tax, increased property tax) generated by project-related activities, local governments may find resources strained to provide these public services. However, because the construction phase would be short, approximately 18 months, local governments may not elect to ramp-up staffing to maintain preconstruction ratios. Furthermore, because the need for professional law enforcement personnel and firefighters would be expected to drop during the operations phase (because the operations workforce is smaller than the construction workforce), local governments may avoid layoffs by modifying hiring practices. The 492 new residents would represent 0.96 percent of the 2007 U.S. Census Bureau estimated region of influence population (USCB 2008b) and 0.82 percent of the projected 2010 region of influence population (Chapter 3, Table 3-22).

4.9.1.7.4 *Impacts to Education During Operations*

The operations positions would likely be filled with approximately 32 workers who would be residing in the region of influence at the completion of the construction phase and by an additional 11 workers who would migrate into the region. The 11 in-migrating operations workers would be expected to have nine school-aged children (Table 4-43). The addition of nine children to the various school districts, based on 2005/2006 school year enrollment, represents a 0.08-percent enrollment increase. The public educational systems in the region of influence would likely experience a decline in project-related enrollment at the end of the construction phase, as most construction workers and their families would leave the region. As discussed in Chapter 3, Section 3.10.2.4.1, Kansas and Oklahoma have school funding equalization programs that strive to ensure that the local school districts would not be unduly burdened to provide educational services to the children of in-migrating workers without additional funding. There are three post-secondary institutions within the region of influence of the Biorefinery Project site. These institutions would be able to absorb any increased enrollment that may result from the in-migrating adult population seeking collegiate education or training.

4.9.1.7.5 *Impacts to Public Services (law enforcement, fire protection, and medical services) During Operations*

The operations workforce would be smaller than the construction workforce. There would be 35 new residents in the region of influence as a result of project operations. There could be additional need for law enforcement, fire protection, or medical services because of the operations induced-population increase. However, impacts to the following preconstruction ratios would be nearly imperceptible: residents-to-law enforcement officers, residents-to-active firefighters, and residents-to-staffed hospital beds. If there where no change in existing staffing levels, the ratio of residents-to-law enforcement officers would increase by 0.07 percent, the ratio of residents-to-active firefighters would increase 0.07 percent, and the ratio of residents-to-staffed hospital beds would increase 0.07 percent. Local governments could evaluate staffing needs during operations in light of changes to staffing levels made during the construction phase. If governments added staff to accommodate new residents during construction, some of these positions could be superfluous during operations. Governments could reduce personnel or leave staffing levels constant and reduce the residents-to-public service employee ratio. If the number of staffed hospital beds and the number of physicians remained constant, the utilization rates of medical services would be lower during operations than during construction. The 35 new residents would represent 0.07 percent of the 2007 U.S. Census Bureau estimated region of influence population (USCB 2008b) and 0.06 percent of the projected 2010 region of influence population (Chapter 3, Table 3-22).

4.9.2 ACTION ALTERNATIVE

4.9.2.1 Construction

Chapter 2 provides details of the biorefinery under the Action Alternative. The impacts to socioeconomic variables during the construction and operations phases would be small. As mentioned, the significance level of impacts to a socioeconomic variable is driven by a change in the region's population. The region's change in population would be induced by the action's workforce demands and the percentage of the workforce that would migrate into the region to accept employment. The expected number of construction workers needed for the Action Alternative at the peak period is 224. Six operations workers would also be employed during the peak period of construction. Approximately 75 percent of the construction workforce and 25 percent of operations workforce would be expected to migrate into the region of influence.

To provide a basis for comparison, Table 4-44 presents information about key socioeconomic variables

Table 4-44. Socioeconomic variables comparison between the Proposed Action and Action Alternative.

Socioeconomic variable	Proposed Action	Action Alternative
Construction phase		
Workers at peak period (construction workers and operations workers employed during construction activities)	256	230
Number of in-migrating workers at peak period	190	170
Change in region's population from in-migrating workers and family members	492	440
Number of in-migrating school aged children	112	101
Number of indirect jobs created by project construction	88	79
Increase in PCI in dollars	322	310
Increase in PCI as percentage of 2006 PCI	1.1	1.1
Annual increased earnings in the region (after multiplier) during peak period	$16,607,090	$15,967,418
Operations phase		
Workers at peak period (fully staffed operations)	43	34
Number of in-migrating workers	11	9
Change in region's population from in-migrating workers and family members	35	28
Number of in-migrating school aged children	9	7
Number of indirect jobs created by biorefinery operations	23	18
Annual increase in PCI in dollars	87	69
Annual increase in PCI as percentage of 2006 PCI	0.3	0.2
Annual increased earnings in the region (after multiplier) during peak period	$4,442,888	$3,512,981

PCI = per capita income.

for both the Proposed Action and the Action Alternative. Changes to socioeconomic variables during construction under the Action Alternative would be small. The number of in-migrating workers (170) and their families would represent an increase of 440 persons in the region of influence. This increase represents 0.86 percent of the 2007 baseline population. Because the increase in population would be so small and the available inventory of existing housing so large, there would be little strain on the existing housing market in terms of new construction or price. The 170 newly created positions would increase the employment base by 0.51 percent. In addition, approximately 70 indirect jobs would likely be created by the additional spending in the region of influence, but all the positions would be filled current residents or by adults accompanying in-migrating workers. The positions would annually generate approximately $16 million in spending (after the earnings multiplier is applied). The additional 101 school-aged children that would be a part of the increased population is 0.94 percent of the 2005/2006 enrollment in the region of influence public school system. Per capita income would increase by 1.1 percent, or $310, over the 2006 baseline. The region of influence 2005 resident-to-sworn law enforcement officer ratio would increase by 0.77 percent to 1601-to-1, and the 2007 resident-to-active fire fighter ratio would also increase by 0.86 percent, to 287-to-1 if staffing levels in both sectors remained at preconstruction levels. The resident-to-staff hospital bed ratio would increase by 0.86 percent, to 401-to-1; approximately 90 percent of that during construction for the Proposed Action. Impacts during construction to all socioeconomic variables under the Action Alternative would be small because the project-induced change in the region's population during construction would be small (440 persons) and of a short duration, approximately 20 months.

4.9.2.2 Operations

Impacts to socioeconomic variables during the operations phase under the Action Alternative would be very small. The Action Alternative operations workforce, 34 workers, would be approximately 79 percent of the operational staff needed for the Proposed Action. Changes to socioeconomic variables during operations would be proportionally smaller than those during operations for the Proposed Action. The impacts for the Proposed Action are larger and are, therefore, bounding. Impacts to all socioeconomic variables under the Action Alternative would be very small because the induced change in the region's population would be very small (28 persons).

4.9.3 SUMMARY OF SOCIOECONOMICS IMPACTS

The Proposed Action would impact socioeconomic variables in the region of influence. Biorefinery construction and operations activities would impact the region's population and housing, employment and income, and education and public services. Impacts would be driven by changes (increases) in population that in turn impact other socioeconomic variables. The increase in population during construction activities (from in-migrating construction worker and operations workers employed during construction) would peak at 492 persons, a 0.96-percent increase over the region's 2007 population. The project-induced population increase of 35 persons during the estimated operational life of the biorefinery represents a 0.06-percent increase over the region's 2007 population. Because the increases in population are small, impacts to other socioeconomic variables are also small, that is, less than 1 percent of the baseline or existing conditions.

The Action Alternative would impact socioeconomic variables in the region of influence. Impacts resulting from the Action Alternative would be small. As a percentage, impacts from the Action Alternative would be approximately 90-percent magnitude of the impacts expected from the Proposed

Action during construction, and even less magnitude, approximately 80 percent of the Proposed Action's impacts, during the operations phase. Impacts to all socioeconomic variables under the Action Alternative would be very small because the project-induced change in the region's population would be very small.

4.10 Cultural Resources

This section describes the potential *cultural resources* impacts associated with the Proposed Action and Action Alternative. Section 4.10.1 describes the impacts of the Proposed Action and Section 4.10.2 describes the impacts of the Action Alternative.

4.10.1 PROPOSED ACTION

4.10.1.1 Impacts to National Historic Register Sites

According to the Kansas State Historic Society in Topeka, Kansas, no recorded sites are located within the Biorefinery Project site or adjacent lands [that is, within the 1-mile (1.6-kilometer) region of influence]. No properties listed on the National Historic Register are within or on properties adjoining the Project site (K&K 2008). Further, based on DOE review of published information, coordination with the State Historic Preservation Office, and the results of the Phase I/II investigation (K&K 2008), construction and operation of the biorefinery would not result in adverse impacts to State or National Historic Register Sites within 1-mile region of influence. No impacts are expected due to the Proposed Action.

4.10.1.2 Impacts to Resources of Local Significance

There are no resources of local significance located on lands comprising the Biorefinery Project site. The Stevens County Gas & Historical Museum complex is located in the southeastern portion of Hugoton. Activities associated with the Proposed Action, that is, construction and operations of the biorefinery, automobile and truck traffic, and railroad deliveries into and out of the Project site related to noise, dust, vibrations, and odor impacts would not have an important impact on the museum. Aesthetics changes would not be significant**.**

4.10.1.3 Graves and American Indian Concerns

DOE sought comment from American Indian tribes about the potential significance of the land at the Biorefinery Project site. DOE received no comments. However, DOE reviewed published information and did not note any tribal properties, cemeteries, or known burial sites within 1-mile of the Project site. Coordination with the Kansas State Historical Society indicated there are no sites on or immediately adjacent to the Project site (K&K 2008). No indication of a prehistoric or early historic occupation were discovered during the onsite Phase I/II investigation (K&K 2008). Therefore, there would be no expected impacts related to graves or American Indians as a result of the Proposed Action.

While unlikely, unmarked graves may be exposed by trenching or below-grade excavation. If such should occur, construction activity would cease within an appropriate radius [no less than 50 feet (15 meters)] until an archaeologist qualified under 36 CFR Part 61 could examine the exposed grave(s) and a Kansas State Historical Society staff member was notified. Tribes would be notified immediately if the grave(s) were determined to potentially contain American Indian remains.

4.10.1.4 Needed Permits, Surveys, or Additional Assessments

4.10.1.4.1 *Impacts within 30 Miles of the Biorefinery Project Site*

Offsite storage of feedstock would occur within 30 miles (48 kilometers) of the Biorefinery Project site. The specific locations of the offsite storage sites are not known at this time; however, the biomass accumulation sites would not be located within or immediately adjacent to any sites listed with the National Historic Register or Kansas State Historical Society (Chapter 3, Figure 3-21). No impacts are expected.

When specific storage locations are selected, the locations and if applicable any development plans would be provided to the Kansas State Historical Preservation Office. The Kansas State Historical Preservation Office would then review the proposed offsite storage locations for the potential to contain significant archaeological or historical resources. If there were no historical structures and the site had a low potential for archaeological resources, the State Historical Preservation Office would provide a clearance letter. If the site was determined to have a significant probability of containing archaeological resources or had adjacent historical or potentially eligible historical structures or sites, then the State Historical Preservation Office would require that Phase II investigations be completed. Phase II investigations would result in a clearance letter if no archaeological resources were found and no sites or structures qualified for additional consideration for the National Historic Register or State Historical Register. If significant resources were present, then the process would progress to a Phase III investigation. Phase III is a *mitigation* phase that would document the resources that are present, recover resources if warranted, recommend measures to prevent impacts, or recommend that another site be chosen.

4.10.1.4.2 *Impacts on the Biorefinery Project Site*

As mentioned above, a Kansas State-approved archaeologist conducted a Phase I/II archaeological survey on a 160-acre portion (northwest quarter of section 17) of the east portion of the Biorefinery Project site and documented its findings in a report dated July 10, 2008 (K&K 2008). This report is appended as Appendix E of this EIS. The survey stated that “there are no Kansas State Historical Society-recorded sites located on or immediately adjacent to the proposed project or within an actionable radius of the project area.” The onsite survey, which included shovel-testing, concluded that, “No cultural materials were discovered during the investigation of the proposed Abengoa project site indicative of a prehistoric or early historic occupation.” DOE anticipates no further study for impacts to cultural resources within the Project site.

While unlikely, buried cultural resources may be exposed by trenching or below-grade excavation. If such should occur, construction activity would cease within an appropriate radius [no less than 50 feet (15 meters)] until an archaeologist qualified under 36 CFR Part 61 could examine the exposed cultural resources and a Kansas State Historical Society staff member was notified.

4.10.2 ACTION ALTERNATIVE

4.10.2.1 Impacts to National Historic Register Sites

According to the Kansas State Historic Society in Topeka, Kansas, no recorded sites are located within the Biorefinery Project site or adjacent lands [that is, within the 1-mile (1.6-kilometer) region of influence]. No properties listed on the National Historic Register are within or on properties adjoining the

Project site (K&K 2008). Further, based on DOE review of published information, coordination with the State Historic Preservation Office, and the results of the Phase I/II investigation (K&K 2008), construction and operation of the biorefinery would not result in adverse impacts to State or National Historic Register Sites within 1 mile of the Project site. No impacts are expected from the Action Alternative.

4.10.2.2 Impacts to Resources of Local Significance

There are no resources of local significance on lands comprising the Biorefinery Project site. The Stevens County Gas & Historical Museum complex is located in the southeastern portion of Hugoton. Activities associated with the Action Alternative, that is, construction and operations of the biorefinery, automobile and truck traffic, and railroad deliveries into and out of the Project site related to noise, dust, vibrations, and odor impacts would not have an important impact on the museum. Aesthetics changes would not be significant**.**

4.10.2.3 Graves and American Indian Concerns

DOE sought comment from American Indian tribes about the potential significance of the land at the Biorefinery Project site. DOE received no comments. However, DOE reviewed published information and did not note any tribal properties, cemeteries, or known burial sites within 1 mile (1.6 kilometers) of the Biorefinery Project site. Coordination with the Kansas State Historical Society indicated there are no sites on or immediately adjacent to the Project site (K&K 2008). No indication of a prehistoric or early historic occupation were discovered during the onsite Phase I/II investigation (K&K 2008). Therefore, there would be no expected impacts related to graves or American Indians from the Action Alternative.

While unlikely, unmarked graves may be exposed by trenching or below-grade excavation. If such should occur, construction activity would cease within an appropriate radius [no less than 50 feet (15 meters)] until an archaeologist qualified under 36 CFR Part 61 could examine the exposed grave(s) and a Kansas State Historical Society staff member was notified. Tribes would be notified immediately if the grave(s) were determined to potentially contain American Indian remains.

4.10.2.4 Needed Permits, Surveys, or Additional Assessments

4.10.2.4.1 *Impacts within 30 Miles (48 kilometer) of the Biorefinery Project Site*

Offsite storage of feedstock would occur within 30 miles of the Biorefinery Project site. The specific locations of these storage sites are not known at this time; however, the storage sites would not be located within or immediately adjacent to any sites listed with the National Historic Register or Kansas State Historical Society (Chapter 3, Figure 3-21). No impacts are expected.

When specific storage locations are selected, the locations and if applicable any development plans would be provided to the Kansas State Historical Preservation Office, as Section 4.10.1.4.2 discusses.

4.10.2.4.2 *Impacts on the Biorefinery Project Site*

As Section 4.10.1.4.1 discusses, a Kansas State-approved archaeologist conducted a Phase I/II archaeological survey of the Biorefinery Project site and documented its findings in a report dated July 10, 2008 (K&K 2008). This report is appended as Appendix E of this EIS. DOE anticipates no further study for impacts to cultural resources within the Project site.

While unlikely, buried cultural resources may be exposed by trenching or below-grade excavation. If such should occur, construction activity would cease within an appropriate radius [no less than 50 feet (15 meters)] until an archaeologist qualified under 36 CFR Part 61 could examine the exposed cultural resources and a Kansas State Historical Society staff member was notified.

4.10.3 SUMMARY OF CULTURAL RESOURCES IMPACTS

There are no properties listed on the National Historic Register within 1-mile (1.6 kilometers) of the Biorefinery Project site (K&K 2008). Further, based on DOE review of published information, coordination with the State Historic Preservation Office, and the results of the Phase I/II investigation (K&K 2008), construction and operations of the biorefinery would not result in adverse impacts to State or National Historic Register sites. No impacts are expected due to the Proposed Action or Action Alternative.

4.11 Health and Safety

This section describes the potential human health and safety impacts associated with the Proposed Action and Action Alternative. Section 4.11.1 describes the impacts of the Proposed Action and Section 4.11.2 describes the impacts of the Action Alternative. Health and safety impacts from transportation and from accidents are described in Sections 4.7 and 4.12, respectively.

4.11.1 PROPOSED ACTION

4.11.1.1 Introduction

This section describes potential health and safety impacts to workers (industrial impacts) and to members of the public (public impacts) from construction and operation of the biorefinery. Workers would be located within the industrial region of influence of the Biorefinery Project site, as defined in Chapter 3, Section 3.12.1 of this EIS, and would be involved in those activities related to its construction and operations. Members of the public would be offsite and would potentially be affected by activities related to the biorefinery.

Construction of the biorefinery would take place over approximately 18 months. Personnel requirements would vary during the construction phase, but would peak with a workforce of 250 persons (Roach 2009p). Construction activities would employ workers from multiple trades, including welders, carpenters, electricians, ironworkers, laborers, plumbers, steamfitters, and pipe fitters.

Personnel requirements during operation of the biorefinery would be approximately 43 workers (Roach 2009ff). This assumes about 32 full-time equivalent workers for ethyl alcohol manufacturing during biorefinery operations, 2.25 full-time equivalent workers for milling and grinding operations, and 9 full-time equivalent workers for power-generation activities.

4.11.1.2 Industrial Health and Safety Impacts

This analysis estimated health and safety impacts to workers from industrial hazards by using *incidence rates* for 2007 for both nonfatal occupational injuries and occupational fatalities from the U.S. Department of Labor, Bureau of Labor Statistics. Nonfatal occupational injury information included two impact categories, *total recordable cases* and *days away from work, days of restricted work activity or job transfer*. These health and safety incident statistics are defined as follows:

- Total recordable cases. The total number of work-related deaths, illnesses, or injuries that resulted in the loss of consciousness, days away from work, restricted work activity or job transfer, or required medical treatment beyond first aid.

- Days away from work, days of restricted work activity or job transfer. Cases that involve days away from work, or days of restricted activity or job transfer, or both.

The Bureau of Labor Statistics provides total recordable cases incidence rates and days away from work incidence rates as the number of injuries per 100 full-time workers. It provides fatality incidence rates as the number of fatalities per 100,000 full-time workers. A full-time worker is assumed to work 2,000 hours per year. Table 4-45 summarizes the health and safety impacts calculated from the Bureau of Labor Statistics incidence rates, with a discussion following.

Table 4-45. Impacts to workers from industrial hazards during construction and operation of the biorefinery under Proposed Action.

Activity	Impact category	Number
Construction phase		
	Total recordable cases	14
	Lost workday cases	7.0
	Fatality	0.026
Operations phase[a]		
	Total recordable cases	2.1
	Total workday cases	0.60
	Fatality	0.00064
Milling/Grinding operations		
	Total recordable cases	0.15
	Total workday cases	0.079
	Fatality	0.00046
Electric power generation		
	Total recordable cases	0.42
	Total workday cases	0.26
	Fatality	0.00035
Total annual impacts during operations		
	Total recordable cases	2.7
	Lost workday cases	0.94
	Fatality	0.0014

Note: Totals may not equal sums due to rounding.
a. Includes impacts from the biorefinery rail spur.

For construction activities, DOE used the Bureau of Labor Statistics incident rates from the Construction category. The total recordable cases incidence rate is 5.4 injuries per 100 full-time employees, and the days away from work, days of restricted work activity or job transfer incidence rate is 2.8 injuries per 100 full-time employees (BLS 2008a). To estimate nonfatal impacts to workers from industrial hazards during construction of the biorefinery, DOE multiplied the incidence rates from the Bureau of Labor Statistics by the number of full-time workers during the construction phase and divided the results by 100. The maximum number of full-time workers is estimated to be 250 during the peak weeks of construction. The calculated number of full-time workers for the construction phase, based on 2,000 hours per year per worker, is about 210 workers (calculated from Roach 2009gg). Using the more conservative assumption of 250 workers, DOE estimates that about 14 total recordable cases and about 7 days away from work would occur during the construction phase. Standard best management practices for the construction industry would be implemented to reduce risks to workers. This includes, but is not limited to, complying with Occupational Safety and Health Agency regulation "Safety and Health Regulations for Construction" (29 CFR Part 1926).

The fatality incidence rate for construction activities is 10.3 fatalities per 100,000 full-time employees based on the Bureau of Labor Statistics (BLS 2008b). To estimate the number of worker fatalities from industrial hazards during construction, DOE multiplied the fatality incidence rate from the Bureau of Labor Statistics by the number of full-time workers during construction of the biorefinery and divided the results by 100,000. Using the more conservative assumption of 250 workers, DOE estimates that about 0.026 fatality would occur during the construction phase. Based on these results, DOE believes that a fatality would be unlikely.

For biorefinery operations activities, DOE used the Bureau of Labor Statistics incidence rates from the Ethyl Alcohol Manufacturing category. The total recordable cases incidence rate is 6.7 injuries per 100 full-time employees and the days away from work, days of restricted work activity or job transfer incidence rate is 1.9 injuries per 100 full-time employees (BLS 2008a). To estimate nonfatal impacts to workers from industrial hazards during biorefinery operations, DOE multiplied the incidence rates from the Bureau of Labor Statistics by the number of full-time workers during operation of the biorefinery and divided the results by 100. The number of full-time workers involved with ethyl alcohol manufacturing during biorefinery operations is projected to be approximately 32 (Roach 2009ff, 2009hh). Therefore, DOE estimates that about 2.1 total recordable cases and about 0.60 day away from work would occur annually during the operations phase due to ethyl alcohol manufacturing during biorefinery operations. Even though neither a facility-specific process safety management plan (Roach 2009ii) nor a facility-specific risk management program (Roach 2009jj) would be required for the biorefinery, training and control procedures would be implemented to minimize risks to workers (Roach 2009ii).

The fatality incidence rate for ethyl alcohol manufacturing during biorefinery operations is 2.0 fatalities per 100,000 full-time employees, based on the Bureau of Labor Statistics Chemical Manufacturing category (BLS 2008b). To estimate the number of worker fatalities from industrial hazards during operations of the biorefinery, DOE multiplied the fatality incidence rate from the Bureau of Labor Statistics by the number of full-time workers that would be involved in ethyl alcohol manufacturing operations at the biorefinery and divided the results by 100,000. DOE estimates that about 0.00064 fatality would occur annually during biorefinery operations with 31.75 full-time equivalent workers.

Milling, grinding, and related operations at the biorefinery could cause injuries that are not part of routine ethyl alcohol manufacturing. DOE used the Bureau of Labor Statistics incidence rates from the Postharvest Crop Activities subcategory of the Agriculture category. The total recordable cases incidence rate is 6.8 injuries per 100 full-time employees and the days away from work, days of restricted work activity or job transfer incidence rate is 3.5 injuries per 100 full-time employees (BLS 2008a). To estimate nonfatal impacts to workers from industrial hazards during milling and grinding operations, DOE multiplied the incidence rates from the Bureau of Labor Statistics by the number of full-time worker years during milling operations at the biorefinery and divided the results by 100. The number of full-time equivalent workers engaged in milling and grinding during operations is projected to be approximately 2.25. This equates to two full-time employees in the biomass grinding area and one maintenance worker in the biomass grinding area at one-quarter time (Roach 2009ff). DOE estimates that about 0.15 total recordable case and about 0.079 day away from work would occur annually during the operations phase due to milling and grinding operations.

The fatality incidence rate for milling and grinding operations is 20.6 fatalities per 100,000 full-time employees, based on the Bureau of Labor Statistics Support Activities for Agriculture category (BLS 2008b). To estimate the number of worker fatalities from industrial hazards during milling operations at the biorefinery, DOE multiplied the fatality incidence rate from the Bureau of Labor Statistics by the number of full-time workers that would be involved in milling operations at the biorefinery and divided the results by 100,000. DOE estimates that about 0.00046 fatality would occur annually during milling operations with 2.25 full-time workers.

The operations that generate electric power at the biorefinery could also cause injuries. DOE used the Bureau of Labor Statistics incidence rates from the Other Electric Power Generation subcategory of the Utilities category. The total recordable cases incidence rate is 4.7 injuries per 100 full-time employees, and the days away from work, days of restricted work activity or job transfer incidence rate is 2.9 injuries per 100 full-time employees (BLS 2008a). To estimate nonfatal impacts to workers from industrial hazards during the generation of electric power, DOE multiplied the incidence rates from the Bureau of Labor Statistics by the number of full-time worker years during power-generating operations at the biorefinery and divided the results by 100. The number of full-time equivalent workers that would be engaged in operations that generate electric power is projected to be nine workers. Therefore, DOE estimates that about 0.42 total recordable case and about 0.26 day away from work would occur annually during the operations phase due to the generation of electricity.

The fatality incidence rate for operations that generate electricity is 3.9 fatalities per 100,000 full-time employees, based on the Bureau of Labor Statistics Utilities category (BLS 2008b). To estimate the number of worker fatalities from industrial hazards during electricity generation at the biorefinery, DOE multiplied the fatality incidence rate from the Bureau of Labor Statistics by the number of full-time workers that would be involved in electricity generation at the biorefinery and divided the results by 100,000. DOE estimates that about 0.00035 fatality would occur annually during electricity generation operations with 9 full-time persons.

Total annual impacts to workers from industrial hazards during operation of the biorefinery are calculated by summing the impacts from ethyl alcohol manufacturing, milling and grinding operations, and electric power generation. DOE estimates that about 2.7 total recordable cases, about 0.94 day away from work, and about 0.0014 fatality would occur annually from all operations at the biorefinery. Based on these results, DOE believes that a fatality would be unlikely.

Industrial health and safety impacts, in addition to those from the Bureau of Labor Statistics occupational injury and illness statistics, can occur during construction and operation of the biorefinery. Sections 4.7 and 4.8.1.2 of this EIS discuss impacts from transportation and noise, respectively.

4.11.1.3 Public Health and Safety Impacts

This section describes the *public health and safety* impacts of routine construction and operations of the biorefinery. Section 4.12 discusses impacts caused by potential accidents or sabotage.

Members of the public are assumed to be offsite of the biorefinery work locations. Therefore, the public would not be affected by the industrial hazards described in Section 4.11.1.2. Impacts during construction and operation of the biorefinery could include impacts from air quality, transportation, and noise and are discussed in Sections 4.2, 4.7 and 4.8.1.2, respectively, of this EIS.

4.11.2 ACTION ALTERNATIVE

This section discusses the health and safety impacts within the region of influence resulting from implementation of the Action Alternative. The primary difference in the biorefinery design in the Action Alternative, compared with the Proposed Action, is that facilities to generate electricity to supply power to the regional power grid would not be constructed or operated. This would affect industrial health and safety impacts because fewer workers would be required during construction and operation of the biorefinery. The health and safety impacts calculated from the Bureau of Labor Statistics incidence rates are described below and are summarized in Table 4-46.

Table 4-46. Impacts to workers from industrial hazards during construction and operation of the biorefinery under the Action Alternative.

Activity	Impact category	Number
Construction phase		
	Total recordable cases	12
	Lost workday cases	6.3
	Fatality	0.023
Operations phase[a]		
	Total recordable cases	2.1
	Total workday cases	0.60
	Fatality	0.00064
Milling/Grinding operations		
	Total recordable cases	0.15
	Total workday cases	0.079
	Fatality	0.00046
Total annual impacts during operations		
	Total recordable cases	2.3
	Lost workday cases	0.68
	Fatality	0.0011

Note: Totals may not equal sums due to rounding.
a. Includes impacts from the biorefinery rail spur.

During construction of the biorefinery, the maximum number of full-time workers is estimated to be 224 persons during the peak weeks of construction. The calculated number of full-time workers for the construction phase, based on 2,000 hours per year per worker, is approximately 190 workers (calculated from Roach 2009gg). Using the more conservative assumption of 224 workers, DOE estimates that about 12 total recordable cases, about 6.3 days away from work, and about 0.023 fatality would occur during the construction phase.

During operation of the biorefinery, DOE estimates that the number of full-time equivalent workers involved in ethyl alcohol manufacturing would be about 32 persons (the same as that in the Proposed Action) and that about 2.1 total recordable cases, about 0.60 day away from work, and about 0.00064 fatality would occur due to ethyl alcohol manufacturing. DOE estimates that the number of full-time equivalent workers involved in milling and grinding would be 2.25 persons (the same as that in the Proposed Action) and that about 0.15 total recordable case, about 0.079 day away from work, and about

0.00046 fatality would occur due to milling and grinding operations. No electric power generation would occur, so no workers would be involved in that activity and, therefore, no impacts would occur. Total annual impacts to workers from industrial hazards during operation of the biorefinery are calculated by summing the impacts from ethyl alcohol manufacturing and milling and grinding operations. DOE estimates that about 2.3 total recordable cases, about 0.68 day away from work, and about 0.0011 fatality would occur annually from all operations at the biorefinery. Based on these results, DOE believes that a fatality would be unlikely.

4.11.3 SUMMARY OF HEALTH AND SAFETY IMPACTS

The potential for adverse impacts to health and safety from the Proposed Action would be very minor, as summarized in the following statements:

- During construction, the industrial health and safety impacts to workers are estimated to be approximately 14 total recordable cases, 7.0 days away from work cases, and 0.026 fatality.

- During operations, the total annual industrial health and safety impacts to workers from all operations at the biorefinery (ethyl alcohol manufacturing, milling and grinding operations, and electric power generation) are estimated to be 2.7 total recordable cases, 0.94 day away from work, and 0.0014 fatality.

- Members of the public are assumed to be offsite of the biorefinery work location. Therefore, the public would not be affected by the industrial hazards described in Section 4.11.1.2 above. (Impacts during construction and operation of the biorefinery from air quality, transportation, and noise are discussed in Sections 4.2, 4.7 and 4.8.1.2, respectively.)

The potential for adverse impacts to health and safety from the Action Alternative would be similar to, but smaller than, that for the Proposed Action as summarized in the following statements:

- During construction, the industrial health and safety impacts to workers are estimated to be approximately 12 total recordable cases, 6.3 days away from work cases, and 0.023 fatality.

- During operations, the total annual industrial health and safety impacts to workers from all operations at the biorefinery (ethyl alcohol manufacturing and milling/grinding operations) are estimated to be 2.3 total recordable cases, 0.68 day away from work, and 0.0011 fatality.

4.12 Facility Accidents and Sabotage

This section describes the potential impacts related to facility accidents and sabotage associated with the Proposed Action and Action Alternative. Section 4.12.1 describes the impacts of the Proposed Action and Section 4.12.2 describes the impacts of the Action Alternative.

4.12.1 PROPOSED ACTION

This section provides an evaluation of impacts to onsite workers and the public from potential accidents during operations at the biorefinery for the Proposed Action. Section 4.11 discusses estimated worker impacts in terms of injuries and fatalities related to biorefinery construction and operations activities.

4.12.1.1 Accident Impacts

In evaluating impacts from accidents, DOE first examined the hazardous materials associated with biorefinery operations. Second, DOE evaluated external and internal events to determine the frequency that selected hazardous materials could be released. Finally, DOE evaluated the consequences of such events.

Based on this evaluation, DOE determined that impacts to the public from accidents include consideration of blast effects as well as release of toxic chemicals. The nearest permanent residence to the ethanol tanks at the biorefinery is a dwelling approximately 0.6 mile (1 kilometer) away (Section 4.8.1.2.2). Public impacts are provided for biorefinery operations only since accidents during the construction phase, such as falls and electrocution, would not have any potential for offsite impacts to the public. The only concentration of people in the region is the city of Hugoton with a 2007 population of 3,412 (city-data.com n.d.). The Hugoton city limits begin at a distance of about 1 mile (1.6 kilometers) from the nearest boundary of the Biorefinery Project site (Chapter 1, Figure 1-2).

4.12.1.1.1 *Hazard Analysis*

In general, the hazards of ethanol production are minor (Reed et al. 1982). Environmental assessments prepared for large ethanol production facilities have identified no accidents resulting in lasting adverse health effects for members of the public near the facilities (DOE 2005, 2007a). The only hazardous materials with the potential for offsite consequences would be chemicals that have the potential to release toxic vapors or produce explosions. As Section 4.6.1.4 describes, the chemicals that would be stored in bulk at the biorefinery include ethanol, aqueous ammonia, sulfuric acid, 50-percent caustic (sodium hydroxide), urea, enzyme mix (cellulase and *hemicellulase*), corn syrup, lime, diammonium phosphate, magnesium hydroxide, denaturant (gasoline), limestone, and a corrosion inhibitor (solution containing calcium nitrite).

Table 4-47 lists the chemicals that would be stored onsite and provides characteristics that are significant in terms of public hazards. Three potential offsite health effects are examined: toxic fumes from accidental fires, blast effects from explosion of vapors, and adverse health effects from exposure to vapors from evaporation or dispersion. For the chemical to produce toxic fumes from fires or blast effects from explosions, it must be flammable, therefore Table 4-47 identifies if the chemical is flammable. To produce offsite adverse health effects from exposure to vapors, the chemical must evaporate after release or be dispersed to the atmosphere by other means (for example, explosions) in order to produce a vapor cloud that can be transported off-site by wind and the vapor must be toxic if inhaled by humans. For each chemical, an evaluation is provided of the evaporation rate and health effects if exposed to vapors. The table also indicates the relative hazard for toxic chemicals by providing a *protective action criteria value* (fourth column). Protective action criteria values are concentration limits that produce specific effects for a large number of chemicals. DOE uses these values to evaluate health effects of exposure to chemicals. Protective action criteria values use acute exposure guideline levels, if available, for a specific chemical.

Table 4-47. Chemicals to be stored at the biorefinery.

Chemical[a]	Storage capacity[a]	Flam-mable	Health effects from exposure to vapor/protective action criteria value[b]	Evaporation potential[c]	Reference
Ethanol	640,000 gal[d] (2,400 m^3)	Yes	Short-term exposure causes irritation of eyes, respiratory system; inhalation of high concentrations may cause effects to the central nervous system/50 mg/m^3	Slow	ILO 2000a
Denaturant (Gasoline)	22,500 gal (85 m^3)	Yes	Short-term exposure causes irritation of eyes, respiratory system; inhalation of high concentrations may cause effects to the central nervous system/500 ppm	Rapid	ILO 2001
50% caustic (Sodium hydroxide)	10,000 gal (38 m^3)	No	Sore throat, cough, labored breathing, shortness of breath/5 mg/m^3	Negligible	ILO 2000b
94% sulfuric acid	50,400 gal (190 m^3)	No	Sore throat, cough, labored breathing, shortness of breath, lung edema/8.7 mg/m^3	Negligible	ILO 2000c
42% urea	13,300 gal (50 m^3)	No	Skin and respiratory tract irritation/15 mg/m^3	Negligible	ILO 1997; Mallinckrodt Baker 2007
Enzyme mix (cellulase and hemicellulase)	53,600 gal (200 m^3)	No	At high concentrations, eye and skin irritation, respiratory system irritation/none found	Not found	Scholar Chemistry 2009; Neogen 2004
20% Aqueous ammonia	30,400 gal (120 m^3)	No	Burning sensation, cough, sore throat, shortness of breath/160 ppm	Rapid	ILO 1995
Corn syrup	53,000 gal (200 m^3)	No	None, used as a food product/not applicable	Not found	
Lime	8,000 ft^3 (230 m^3)	No	Burning sensation, cough, shortness of breath, sore throat/none found	Negligible	ILO 1997b
Corrosion inhibitor (calcium nitrite solution)	400 gal. (1.5 m^3)	No	Irritation to respiratory system/0.6 mg/m^3	Slow	ILPI 2008
50% Magnesium hydroxide	1,000 gal (3.8 m^3)	No	None, used as a laxative and antacid/not applicable	Not found	
Diammonium phosphate	500 gal (1.9 m^3)	No	Eye irritation/none found	Negligible	ILO 1998; PotashCorp 2007
Limestone	3,000 ft^3 (85 m^3)	No	Dust may irritate eyes, skin, nasal passages, and respiratory tract/none found	Negligible	Martin Marietta 2006

a. Source: Section 4.6.1.4 of this EIS.
b Source: EMI-SIG 2008.
c. At 20° Celsius (68° Fahrenheit).
d. Includes 460,000 gallons (1,700 m^3) denatured ethanol in a bulk storage tank, 60,000 gallons (230 m^3) ethanol in two product shift tanks, and a tank containing 60,000 gallons (230 m^3) off-specification ethanol
$ft.^3$ = cubic feet.
gal = gallon.
mg/m^3 = milligrams per cubic meter.
ppm = parts per million.

If an acute exposure guideline level is not available, emergency response planning guideline values are used. If neither of these values is available, temporary emergency exposure limit values are used (SCAPA n.d). Four different Protective action criteria threshold concentration values are provided for each chemical. These values are defined as follows (SCAPA n.d):

Level 0 = No adverse health effect
Level 1 = Mild transient effects
Level 2 = Irreversible or other serious health effects that could impair ability to take action
Level 3 = Life-threatening health effects

For the purposes of this analysis, protective action criteria level 2 was selected as the threshold concentration of interest since it is the level that can produce permanent health effects. Protective action criteria level 2 values for chemicals of interest are provided in the fourth column of Table 4-47. These levels are given in parts per million for gases and volatile liquids and in milligrams per cubic meter for particulate materials and nonvolatile liquids (EMI-SIG 2009).

As shown in Table 4-47, the only chemicals that are flammable are ethanol and gasoline. Since both gasoline and ethanol are burned as a common vehicle fuel, it is well known that neither chemical produces toxic gases from combustion. The only chemicals that have non-negligible evaporation potential and also potential adverse health effects are ethanol, gasoline, and 20-percent aqueous ammonia. Airborne dispersal from nearby explosions could also occur, and are considered in Section 4.12.1.1.2. Leaks of non-flammable toxic chemicals with negligible evaporation potential (such as sulfuric acid) could also occur. However, these releases would be expected to be confined to the site and nearby environs and would not create a potential for public exposure.

External Events

External events that can initiate accidents involving a chemical release from tanks are events that originate from outside the site boundaries. DOE used Table 4-48, extracted from *Final Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada* (DOE 2002) to screen the potential biorefinery site to identify accident initiators from external events. This list represents a comprehensive compilation of external events that were screened to determine those that could pose a threat to the biorefinery.

From the list in Table 4-48, external events retained for analysis are evaluated in the following sections.

Table 4-48. External events evaluated as potential accident initiators.

Event	Relation to biorefinery project	Comments
Aircraft Crash	Applicable – Retained for analysis	
Avalanche	Not applicable due to site characteristics	Site consists of flat land with no nearby mountains to initiate an avalanche.
Coastal erosion	Not applicable due to site location	
Dam failure	Not applicable due to site characteristics	No large water impoundment sites are known to exist near site (Chapter 3, Section 3.4.1.4)
Debris avalanche	Not applicable due to site characteristics	Site consists of flat land (Chapter 3, (Section 3.3.5.2)
Dissolution	Not applicable as an accident initiator	

Table 4-48. External events evaluated as potential accident initiators (continued).

Event	Relation to biorefinery project	Comments
Epeirogenic displacement	Not applicable due to site characteristics	Tilting of the Earth's crust—not a likely event due to low seismic region
Erosion	Not applicable due to site characteristics	Low precipitation potential and lack of rivers and streams at or near site
Extreme wind	Not applicable due to site characteristics	Tornadoes, which are included for evaluation, are the only source of extreme winds for the site
Extreme weather	Not applicable due to site characteristics	Tornadoes, which are included for evaluation, are the only known extreme weather conditions
Fire (range)	Applicable – Retained for analysis	
Flooding	Not applicable due to site characteristics	Flooding potential minimal due to lack of large rivers, lakes, reservoirs in area
Denudation	Not applicable as an accident initiator	Loss of vegetation will not affect the integrity of the ethanol tanks
Fungus, bacteria, algae	Not applicable as an accident initiator	Fungus, bacteria, or algae as an external event will not affect the integrity of the ethanol tanks
Glacial erosion	Not applicable due to site characteristics location	
High lake level	Not applicable due to site characteristics	No large lakes in site vicinity (Chapter 3, Section 3.4.1.4)
High tide	Not applicable due to site location	
High river stage	Not applicable due to site characteristics	No large rivers in region (Chapter 3, Section 3.4.1.4)
Hurricane	Not applicable due to site location	
Inadvertent future intrusion	Not applicable as an accident initiator	Applies only to underground facilities.
Industrial activity	Retained for further evaluation	
Intentional future intrusion	Not applicable as an accident initiator	Applies only to underground facilities
Lightning	Retained for further evaluation	
Loss of offsite or onsite power	Retained for further evaluation	
Low lake level	Not applicable as an accident initiator	
Meteorite impact	Retained for further evaluation	
Military activity	Not applicable due to site characteristics	No military activity is known to exist in the site vicinity
Orogenic diastrophism	Not applicable due to site location	Movement of Earth's crust by tectonic processes is not applicable at the site
Pipeline rupture	Retained for further evaluation	
Rainstorm	Not applicable as an accident initiator	
Sandstorm	Not applicable as an accident initiator	
Sedimentation	Not applicable as an accident initiator	
Seiche	Not applicable due to site location	A seiche is a water surge that requires a large, shallow body of water.
Seismic activity	Retained for further evaluation	

Table 4-48. External events evaluated as potential accident initiators (continued).

Event	Relation to biorefinery project	Comments
Stream erosion	Not applicable due to site location	No streams in vicinity of site (Chapter 3, Section 3.4.1.4)
Subsidence	Included in seismic activity	Sinking of the earth's surface
Tornado	Retained for further evaluation	
Tsunami	Not applicable due to site location	
Undetected past intrusions	Not applicable as an accident initiator	Applies only to underground facilities
Undetected geologic features	Not applicable as an accident initiator	
Volcanic eruption	Not applicable due to site location	No known historically active volcanoes in region (Chapter 3, Section 3.3.5.2)
Volcanism (magmatic, ash flow, ash fall	Not applicable due to site location	No known active volcanoes in region (Chapter 3, Section 3.3.5.2)
Waves (aquatic)	Not applicable due to site location	

Source: DOE 2002.

Aircraft Hazard

An airport serving the city of Hugoton, Kansas, is 1.3 miles (2.1 kilometers) to the southeast of the Biorefinery Project site. The main runway is oriented in the northeast-southwest direction, and the crosswind runway is perpendicular to the main runway (Airnav 2008). The airport is for general aviation (no commercial or military air travel operations use the airport) (Airnav 2008). The number of aircraft movements is 27 per day, or about 9,900 per year (Airnav 2008). DOE used a method developed by the U.S. Nuclear Regulatory Commission to evaluate the probability of aircraft crashes into the biorefinery (NRC 1987). In this method, the following formula is used for estimating the probability per year of an aircraft crashing into a site for cases where the airport is in close proximity to the site (NRC 1987):

$$P_A = S_L\ S_M\ C_j \times N_{ij} \times A_j \qquad \text{(Equation 4-1)}$$

Where:

P_A = the annual probability per square mile of an aircraft crash into the site
S_L = the summation over all flight trajectories affecting the site
S_M = the summation over all different types of aircraft (commercial, military, and general aviation) using the airport
C_j = the probability per square mile of a crash per aircraft movement for the jth aircraft type
N_{ij} = the number (per year) of aircraft movements by each type of aircraft along each flight path
A_j = the effective facility area in square miles for the jth aircraft type.

Since only one type of aircraft utilizes the Hugoton airport (general aviation), the formula reduces to:

$$P_A = C \times N \times A \qquad \text{(Equation 4-2)}$$

For general aviation, C is 1.5×10^{-7} (NRC 1987, Table 6.4.1) for the case where the facility is 1 to 2 miles (1.6 to 3.2 kilometers) from the end of the runway. If the number of aircraft movements per year is 9,900, then P_A is approximately 1.5×10^{-3} per square mile of facility effective area. The effective area of the facility is the sum of the fly-in area (area of the facility vulnerable to direct impact by an airborne aircraft) and the skid area (area of the facility vulnerable to indirect impact by an aircraft that strikes the ground near the facility and then skids into facility structures). The general formulas for these two effective area components are (BSC 2006):

$$A_{fly\text{-}in} = LW(1+2G/D) + (G+D)H\cot Ø \quad \text{(Equation 4-3)}$$

$$A_{skid} = (D+G)S \quad \text{(Equation 4-4)}$$

Where:

L = length of the facility vulnerable area
W = width of the facility vulnerable area
G = wingspan of the aircraft
D = diagonal of the facility vulnerable area
H = height of the facility vulnerable area
Ø = approach angle of the ground
S = skid distance.

As shown in Section 4.12.1.1.1, the largest quantity of a toxic chemical that would be stored in bulk at the biorefinery is ethanol. Ethanol would be stored in four separate tanks with a total volume of 405,000 gallons (1,500 cubic meters). Accordingly, DOE selected the ethanol tanks as the largest vulnerable target area for a potential aircraft crash accident. Thus, the probability of an air crash on the ethanol tanks would bound the probability of a crash on any of the other tanks containing a toxic chemical. The capacities and dimensions of the tanks are given in Table 4-49.

Table 4-49. Capacities and dimensions of ethanol tanks.

Tank	Number	Capacity [gallons (cubic meters)]	Diameter [feet (meters)]	Height [feet (meters)]
Storage	1	460,000 (1,700)	45 (14)	39 (12)
Off-specification	1	60,000 (230)	20 (6.1)	26 (7.9)
Product shift	2	60,000 (230)	20 (6.1)	26 (7.9)

Source: Roach 2009z.

Since the tanks are cylindrical, the values for L, W, and D in the previous equations would be the diameter of the tanks. The aircraft wingspan (G) for general aviation aircraft (piston engine) is 50 feet (15.2 meters) (BSC 2006, Table 6). The approach angle, Ø, for general aviation aircraft is 7 degrees, and cotØ is 8.2 (BSC 2006, Table 6). The skid distance, S, for general aviation aircraft is 60 feet (BSC 2006, Table 6). Therefore, the numerical value of $A_{fly\text{-}in}$ for the ethanol storage tanks is:

$$A^{st}_{fly\text{-}in.} = (45)(45)(1+2(50)/45) + (50 + 45)(39)(8.2) = 36{,}900 \text{ square feet (3,400 square meters)}$$

and A^{st}_{skid} is

$$A^{st}_{skid} = (45 + 50)(60) = 5{,}700 \text{ square feet (530 square meters).}$$

The total effective area for the tank is then 42,600 square feet (4,000 square meters).

For the off-specification ethanol tank, the numerical value of $A_{fly\text{-}in}$ would be:

$$A^{os}_{fly\text{-}in} = (20)(20)(1+2(50)/20) + (50 + 20)(26)(8.2) = 17{,}300 \text{ square feet (1,600 square meters)}$$

and A^{os}_{skid} is

$$A^{os}_{skid} = (20 + 50)(60) = 4{,}200 \text{ square feet (390 square meters).}$$

The total effective area for the off-specification tank is then 21,500 square feet (2,000 square meters).

For the two shift tanks, the numerical value of $A_{fly\text{-}in}$ would be:

$$A^{st}_{fly\text{-}in.} = 2[(20)(20)(1+2(50)/20) + (50 + 20)(26)(8.2)] = 34{,}600 \text{ square feet } (3{,}200 \text{ square meters})$$

and A^{st}_{skid} is

$$A^{st}_{skid} = 2[20+50)(60)] = 8{,}400 \text{ square feet } (780 \text{ square meters}).$$

The total effective area for the two shift tanks is then 43,000 square feet (4,000 square meters).

Thus, the total effective area is the sum of all the tank effective areas, or 36,900 square feet + 21,500 square feet + 43,000 square feet, for a grand total of 101,000 square feet or 3.7×10^{-3} square miles (9.6×10^{-3} square kilometers). From this result, DOE estimates the annual probability of an airplane strike onto an ethanol tank at the biorefinery to be, from Equation 4-2,

$$P_A = C \times N \times A = (1.5 \times 10^{-3})(3.7 \times 10^{-3}) = 5.6 \times 10^{-6} \text{ per year.}$$

It is possible that aircraft movements will increase in the future at the Hugoton airport due to regional population increases. However, the population of Hugoton has actually decreased 6 percent from 2000 to 2007 (city-data n.d.). The biorefinery is expected to employ 43 permanent staff (Section 4.9.1.4). DOE estimates that only 11 of these employees would migrate into the region of influence; the remainder would be part of the existing region of influence labor pool (Section 4.9.1.4). Considering all family members, DOE estimates that the 11 workers would represent a population increase of 35 persons (Section 4.9.1.5). Assuming that all of these family members resided in the nearby town of Hugoton, DOE estimates that the population would increase by about 0.01 percent since the 2007 population of Hugoton was 3,412 (city-data n.d.). DOE assumed this population increase would result in a corresponding increase in aircraft operations at the Hugoton airport. Thus, DOE estimates that the aircraft strike probability for the ethanol tanks would increase by 0.01 percent, which would not change the aircraft crash probability significantly from the estimated value of 5.6×10^{-6} per year. This probability is considerably less than the tank failure probability estimated from internal event initiators considered later in this section. Thus, this accident initiator was not evaluated further.

Fire (range)

Range fires represent a potential external event that could initiate an accident by imposing thermal stress on the toxic chemical storage tanks. However, since the biorefinery is to be operated 24 hours a day, 350 day a year, it is expected that range fires would be detected early, and local fire protection equipment would be employed to extinguish the fire before any threat to the biorefinery ensued. Furthermore, the tanks would be inside the site boundary (Roach 2009j), separated from open range surrounding the site. Thus, a vegetation-free area would be maintained around the tanks that would eliminate the potential for range fires to reach and damage the ethanol tanks.

Industrial Activity

The only known industrial activity near the site with the potential for initiating accidents at the biorefinery is the storage of grain in grain elevators. Grain storage introduces the potential for grain dust explosions. However, as noted in the Pipeline Rupture section following, such offsite explosions would not be expected to result in an accident at the site that would result in permanent offsite health impacts.

Lightning

Lightning could strike the chemical storage tanks and cause tank leakage or ignition of the chemical if flammable. However, appropriate facility lightning protection is to be provided (Roach 2009kk). While tank damage could occur from lightning strikes even with protection, the Biorefinery Project site does not have unique lightning hazards (NWS n.d.). Thus, the probability of tank damage from lightning strikes is expected to be much less than that from internal events as evaluated in Sect 4.12.2.1.2. Therefore, DOE did not consider lightning hazards further.

Loss of Offsite Power

The chemical storage tanks are passive structures that would not need electrical power to maintain integrity. Therefore, loss of offsite power does not constitute an accident-initiating event.

Meteor Impact

DOE evaluated the potential for a meteor strike on the ethanol tanks and found the event to be incredible. This conclusion is based on the following analysis. Small meteors dissipate their energy in the upper atmosphere and have no effect on the surface of the earth. Only when the incoming projectile is larger than about 33 feet (10 meters) in diameter does it begin to pose some hazard to humans (DOE 2002). A meteor in the range of 10 meters in diameter strikes the earth about once per decade, or a probability of 0.1 per year (DOE 2002). Since the radius of the earth is 6,383 kilometers (3,963 miles), the surface area of the earth is 5.11×10^8 square kilometers (2.0×10^9 square miles). Thus, the probability of a hazardous meteor strike on a specific square kilometer of area on the surface of the earth is $(0.1/5.11) \times 10^8 =$ 1.96×10^{-9} per year. Since the footprint area of the bounding tank area (four ethanol storage tanks) at the biorefinery is far less than 1 square kilometer (see Tornado Risks following), a meteor impact probability would be less than 1.96×10^{-9} per year. This result is below the threshold probability recommended by DOE (1×10^{-7} per year) for consideration of an accident scenario (DOE 2004), and is far less than the tank failure probability estimated by DOE from internal initiators (Section 4.12.1.1.2). Thus, DOE did not evaluate this event further.

Pipeline Rupture

An underground natural gas pipeline is located near the Biorefinery Project site. Rupture of this pipeline could allow accumulation of natural gas vapors that could explode if an ignition source were present. The explosion could cause failure of toxic chemical tanks. However, as noted in Section 4.12.1.1.2, explosions from sources on the Project site would not be expected to result in an accident that could cause permanent offsite health effects even if toxic chemical storage tanks were to fail.

Tornado Risks

The biorefinery would be located in Stevens County, Kansas. This location is in a region where significant tornado activity has occurred. In Stevens County, a total of 19 tornados were observed between 1950 and 2000, an average of 0.38 per year (Cowley County n.d.). Tornado wind velocities are classified using the Fujita scale. This scale ranges from F0 up to F5 with corresponding wind velocity ranges assigned to each F value (NRC 1987). On the Fujita scale, the wind speeds range from 40 to 72 miles per hour (18 to 32 meters per second) for F0 events up to a range from 261 to 318 miles per hour (120 to 140 meters per second) for F5 events (NRC 1987). The biorefinery is designed to withstand winds up to a velocity of 90 miles per hour (40 meters per second) (Roach 2009ll). Therefore, any tornado classified as F1 [wind range of 73 to 112 miles per hour (33 to 50 meters per second)] or greater would be expected to cause damage to a chemical storage tank. Table 4-50 provides characteristics of F1 through F5 tornados that DOE used to calculate the probability of a tornado strike on the tank. The tornado intensity (Fujita scale) is given in the first column. The second column gives the frequency distribution (fraction) of tornados in each intensity group from over 20,000 tornado events recorded in the United States (NRC 1987). DOE assumed that the frequency distribution of tornado intensities for the United States applies to the region of the biorefinery. The third column provides the expected annual frequency of a tornado in Stevens County with each F scale intensity. This frequency is computed as the product of the frequency values in the second column with the annual average tornado occurrences in Stevens County (0.38). The last column lists the damage area in square miles for each tornado intensity (NRC 2007a).

Table 4-50. Tornado characteristics.

Intensity (Fujita scale)	United States frequency distribution	Stevens County strike frequency (per year)	Expected damage area [square miles (square kilometers)]
F1	0.41	0.16	0.2921 (0.76)
F2	0.26	0.10	1.1137 (2.9)
F3	0.063	.024	3.1408 (8.1)
F4	0.013	4.9×10^{-3}	5.0186 (13)
F5	1.2×10^{-3}	4.6×10^{-4}	6.0152 (16)

The probability of a tornado with a specific intensity striking a tank is the product of the frequency of a tornado strike in Stevens County, the area ratio for Stevens County [the expected damage area of the tornado divided by the area of Stevens County, 729 square miles (1,900 square kilometers)] (Stevens County n.d.), and the strike area of the tanks. As noted in the previous analysis of aircraft crash, the strike area of the ethanol tanks bounds the tank area of any other chemical. The strike area of the tanks would be the footprint area of the tanks, or $(\pi/4)(\text{tank diameter})^2$. Thus, from Table 4-49, the footprint area of the ethanol tanks would be:

Ethanol storage tank: $\pi(45)^2/4$ = 1,590 square feet (148 square meters)

Off-specification tank: $\pi(20)^2/4$ = 314 square feet (29 square meters)

Shift tanks: 2 $\pi(20)^2/4$ = 628 square feet (58 square meters)

for a total footprint area of 2,532 square feet (240 square meters), or 9.1×10^{-5} square miles (2.4×10^{-4} square kilometers).

The total probability of a tank strike is the sum of the probability of a strike for each tornado intensity, F1 through F5. Table 4-51 provides the results of this calculation.

Table 4-51. Ethanol tank tornado strike probability.

Intensity (Fujita scale)	Stevens County strike frequency (per year)	Expected damage area [square miles (square kilometers)]	Area ratio	Tank strike probability (per year)
F1	0.16	0.29 (0.75)	4.0×10^{-4}	5.8×10^{-9}
F2	0.10	1.11 (2.9)	1.5×10^{-3}	1.4×10^{-8}
F3	0.024	3.14 (8.1)	4.3×10^{-3}	9.4×10^{-9}
F4	4.9×10^{-3}	5.02 (13)	6.9×10^{-3}	3.1×10^{-9}
F5	4.6×10^{-4}	6.02 (16)	8.2×10^{-3}	2.5×10^{-10}
Total				3.3×10^{-8}

Thus, DOE estimates that the probability of a tornado strike on an ethanol tank with the capability of damage is 3.3×10^{-8} per year below the threshold probability recommended by DOE (1×10^{-7} per year) for consideration of an accident scenario (DOE 2004), and far less than the tank failure probability estimated from internal event initiators (Sect. 4.11.2.1.2). Thus, DOE did not evaluate this accident further. Although DOE determined that this scenario is not reasonably foreseeable, DOE nevertheless examined the consequences of accidental or deliberate releases of each of the chemicals listed in Table 4-47.

Seismic Activity

Earthquakes can occur near the biorefinery with the potential to damage the ethanol storage tanks. The seismic hazard map for Stevens County, Kansas, indicates the County is located in a seismic area that could experience a peak ground acceleration in the range of 0.04 to 0.06 times gravitational acceleration based on a 2-percent probability of exceedance in 50 years (Chapter 3, Section 3.3.5.2). Therefore, the Biorefinery Project site could experience an earthquake with a peak ground acceleration of 0.04 to 0.06 gravitational acceleration or greater with a probability of 4×10^{-4} per year ($0.02 \times 1/50$). The estimated generic fragility (capability to resist earthquake ground motion) for large, flat-bottom storage tanks is 1.1 times gravitational acceleration (NRC 1998). Thus, the annual probability of exceedance for a 1.1-times gravitational acceleration event would be far less than 4×10^{-4} per year. Based on a typical seismic hazard curve (DOE 2002), the return frequency for an earthquake producing a peak ground acceleration of 1.1 times gravitational acceleration or greater is more than two orders of magnitude less than a 0.06 times gravitational acceleration or greater event. Therefore, DOE estimates that the probability of damage to the ethanol storage tanks from a seismic event would be less than 4×10^{-6} per year and thus does not contribute to the probability of tank failure from internal events, as estimated in Section 4.12.2.1.2. Consequently, DOE did not evaluate this accident initiator further.

Internal Events

Internal events refers to accident initiators that result from mishaps internal to the facility. Such events can include collisions between the tanks and a vehicle or a piece of equipment being moved by a crane, and explosions near the tanks, or defective fabrication of the tank. To estimate the probability of an ethanol tank failure from internal events, DOE examined several data sources. Table 4-52 lists three tank failure probabilities.

DOE conservatively selected the highest value (8.8×10^{-4} per year) as representative of a chemical storage tank failure probability from internal events.

Table 4-52. Tank failure probabilities and sources.

Failure mode	Probability (per year)	Source
Tank fails catastrophically[a]	$< 1 \times 10^{-4}$	DOE 2005, Appendix E, Section E.2
Tank fails catastrophically	8.8×10^{-4}	EPRI 1992, p. A.A-27
Tank leakage – large[b]	1.9×10^{-5}	NRC 2007b, Table 5.1

a. For moderately pressurized tank (less than 150 psig).
b. Unpressurized tank.

4.12.1.1.2 *Consequences*

This section provides an assessment of consequences for accidents identified above and also for potential sabotage events.

Accident Consequences

Ethanol facilities have been operating in the United States since 1980. As of January 2007, 110 ethanol facilities were operating in the United States (RFA 2009) and many more operate worldwide. There have been no reported adverse health impacts to members of the public due to accidents from operation of these facilities, even though some serious accidents have occurred. For example, in October of 2003, ethanol vapors in a 40,000-gallon (150,000-liter) mash holding tank in Benson, Minnesota, exploded due to unsafe welding (DOE 2005). In August of 2000, an explosion and fire occurred at an ethanol facility in Huron, South Dakota (CTD 2009). In February of 2008, a 30,000-gallon (114,000-liter) ethanol storage tank west of Harristown, Illinois, exploded. There have also been numerous ethanol spills, fires, and explosions in distilleries and during transport of ethanol in railroad tanks, cars, and tanker trucks (Health and Safety Laboratory, 2008). In addition, some ethanol storage tank accidents have occurred outside the United States. For example, in Port Kembla, Australia, an ethanol storage tank containing 7 million liters (1,840,000 gallons) exploded in January 2004 (ABC 2004). However, there were no reported adverse health impacts to members of the public from any of these accidents.

DOE evaluated the potential adverse impact from accidental release of toxic chemicals and considered each of the toxic chemicals in Table 4-47. These chemicals are ethanol, gasoline, sodium hydroxide, sulfuric acid, urea, cellulose, lime silo, and diammonium phosphate. As indicated in the discussion that follows, these chemicals are commonly used in the ethanol industry as well as in other applications and do not represent unique or unusual toxic hazards. For example, one of the most toxic chemicals (lowest threshold limit value per Table 4-47) is sulfuric acid. Sulfuric acid is one of the most common products used in the chemical industry, with 165 million tons produced in 2001. This chemical has been produced, transported, and used safely in the United States for many decades. Similarly, lime, urea, and cellulase with low threshold limit values are widely and safely used common chemical compounds, and diammonium phosphate is the most widely used fertilizer in the world (Simplot n.d.).

Ethanol

Due to the very large inventory of ethanol that could be stored at the biorefinery (640,000 gallons in four tanks per Table 4-47), DOE considered ethanol hazards indepth. Ethanol is considered moderately toxic (Reed et al. 1982). As noted in Table 4-47, exposure to ethanol vapor can cause irritation of the skin and eyes, and inhalation of high concentrations may cause effects to the central nervous system. The protective action criteria level 2 value from Table 4-47 is a relatively high 50 milligrams per cubic meter, indicating a relatively low hazard potential. Ethanol has a strong, agreeable odor (Scifun 2009). Thus, exposed persons would smell and be warned of the presence of the vapor before dangerous concentrations would develop. The nearest permanent residence to the ethanol storage tanks at the biorefinery is 2,600 feet (790 meters) and the nearest city is Hugoton, approximately 1 mile (1.6 kilometers) away. The ethanol storage tanks would have floating roofs in combination with fixed roofs for control of vapor buildup (ABHK 2008). Thus, DOE does not consider an explosion of ethanol vapors in the tanks a likely event, and even if it did occur would not be expected to cause offsite human health effects based on ethanol explosions that have occurred in other ethanol facilities as noted previously.

If a tank were to fail, the discharged ethanol would be confined to the immediate area of the tank by a berm that would surround the tanks (Section 4.6.1.4). Evaporation from the resulting ethanol pool could cause buildup of an explosive air-vapor mixture and could eventually result in a local explosion. Such vapors could also be transported by wind to offsite receptors. However, the low evaporation rate for ethanol (Table 4-47) would limit the concentration buildup and minimize the potential for a large explosive mixture or a high concentration of ethanol in a plume that is transported offsite by wind (Health and Safety Laboratory 2008). If an ethanol tank were to fail, emergency response measures would be implemented in accordance with the *Spill Prevention, Control, and Countermeasures Plan* that applies to the biorefinery (WLA 2008a). This Plan would include notification of local emergency response authorities as well as implementation of remediation activities to minimize the effect of the ethanol discharge.

In view of the preceding, DOE concludes that offsite impacts to the public from accidents involving ethanol tanks at the Biorefinery Project site would be small and no permanent health effects would be likely to occur.

Workers near the released ethanol could inhale the released vapors. This could cause, as noted in Table 4-47, irritation to the eyes and respiratory system. If the vapor concentration was high, effects to the central nervous system could occur. However, since the vapors would be detected by odor, it would be expected that workers would evacuate to avoid prolonged exposure. If the ethanol vapor concentration reached the explosive limit and an ignition source was available, an ethanol explosion could occur, causing injury and, in unusual circumstances, death to nearby workers.

Gasoline

Gasoline has a relatively high protective action criteria level 2 value (Table 4-47), indicating only moderate toxicity. Because of a rapid evaporation rate (Table 4-47) it is possible that gasoline vapors could build up quickly if the 22,500-gallon (85-cubic meter) gasoline storage tank were to fail. Since gasoline is flammable, these vapors could cause an explosion if build-up of a sufficient concentration were to occur and an ignition source was present. The vapors could also be transported offsite and result in exposure to offsite members of the public. However, it is not expected that an explosion would result in adverse offsite health effects because of the limited quantity of gasoline available and the distance from the biorefinery to public receptors. Further, since the odor detection threshold is very low for gasoline (0.5 to 0.6 parts per million; AHC 2004) the presence of the vapor would be detected before hazardous concentrations could develop. As noted previously, a fire involving gasoline would not produce toxic vapors. If the gasoline storage tank were to fail, emergency response measures would be implemented in accordance with the *Spill Prevention, Control, and Countermeasures Plan* that applies to the facility (WLA 2008a). These actions would minimize the potential for offsite exposure.

Workers near the released gasoline could inhale the released vapors. This could cause, as noted in Table 4-47, irritation to the eyes and respiratory system. If the vapor concentration was high, effects to the central nervous system could occur. However, since the vapors would be detected by odor, it would be expected that workers would evacuate to avoid prolonged exposure. If the gasoline vapor concentration reached the explosive limit, and an ignition source was available, a gasoline explosion could cause injury and, in unusual circumstances, death to nearby workers.

Sodium Hydroxide (50 percent)

Sodium hydroxide is a caustic chemical with a relatively low protective action criteria level 2 value of 5 milligrams per cubic meter (Table 4-47), indicating a significant toxic chemical. However, sodium hydroxide is not flammable and has a negligible evaporation rate. Thus, failure of a sodium hydroxide storage tank would not result in a significant release of vapors and no fire would occur. It is possible that an explosion near the sodium hydroxide storage tank could cause tank failure and dispersal of some of the chemical as a vapor in the atmosphere. However, the tank would be isolated from other biorefinery facilities (Section 4.6.1.4) such that an explosion would not be expected to create significant dispersal even if the tank were to fail. Furthermore, sodium hydroxide is a relatively heavy liquid (specific gravity of 2.1; ILO 2000b), such that any liquid dispersed in the atmosphere would tend to precipitate out and not remain available for inhalation. Thus, DOE does not consider failure of a sodium hydroxide storage tank to have significant potential for adverse offsite health effects.

Workers near a sodium hydroxide spill from tank failure could experience adverse inhalation effects including sore throat, cough, and labored breathing (Table 4-47).

Sulfuric Acid (94 percent)

Sulfuric acid is a strong acid that has a low protective action criteria level 2 value of 8.7 milligrams per cubic meter (Table 4-47), indicating significant toxicity. However, sulfuric acid is not flammable and has a negligible evaporation rate (Table 4-47). Thus, failure of a sulfuric acid storage tank would not result in a significant release of vapors and no fire would occur. It is possible that an explosion near the sulfuric acid storage tank could cause tank failure and dispersal of some of the chemical as a vapor in the atmosphere. However, the tank would be isolated from other biorefinery facilities (Section 4.6.1.4) such that an explosion would not be expected to create significant dispersal even if the tank were to fail. Furthermore, sulfuric acid is a relatively heavy liquid (specific gravity of 1.8; ILO 2000c) such that any liquid dispersed in the atmosphere would tend to precipitate out and would not be expected to remain in the atmosphere at locations remote from the biorefinery. Thus, DOE does not consider failure of a sulfuric acid storage tank to have significant potential for adverse off-site health effects.

Workers near a sulfuric acid spill from tank failure could experience adverse inhalation effects including sore throat, cough, and labored breathing and possibly lung edema (Table 4.-47).

Urea (42 percent)

Urea is an organic chemical compound containing nitrogen, commonly used in fertilizers, plastics, animal feed, glues, and diuretics (Wisegeek n.d). It has a low protective action criteria level 2 value of 15 milligrams per cubic meter (Table 4-47), indicating moderate toxicity. However, urea is not flammable and has a negligible evaporation rate (Table 4-47). Thus, failure of a urea storage tank would not result in a significant release of vapors and no fire would occur. It is possible that an explosion near the urea storage tank could cause tank failure and dispersal of some of the chemical as a vapor in the atmosphere. However, the tank would be isolated from other biorefinery facilities (Section 4.6.1.4) such that an explosion would not be expected to create significant dispersal even if the tank were to fail. Thus, DOE does not consider failure of a urea storage tank to have significant potential for adverse off-site health effects.

Workers near a urea spill from tank failure could experience adverse inhalation effects including skin and respiratory tract irritation (Table 4-47).

Enzyme mix (cellulase and hemicellulase)

Cellulase and hemicellulase are a class of enzymes produced by fungi, bacteria, and protozoans. They are used in food processing, laundry detergents, and in the fermentation of biomass into biofuels. As noted in Table 4-47, neither cellulase nor hemicellulase is flammable. Thus, failure of the tank containing the enzyme mix would not result in a fire. It is possible that an explosion near the enzyme storage tank could cause tank failure and dispersal of some of the chemical as a vapor in the atmosphere. However, the tank would be isolated from other biorefinery facilities (Section 4.6.1.4) such that an explosion would not be expected to create significant dispersal even if the tank were to fail. Therefore, DOE would not expect adverse health impacts to members of the public. Workers near the enzyme mix vapors produced by an explosion could experience irritation to the eyes, respiratory system, and skin if high concentrations were produced (Table 4-47).

Aqueous Ammonia (20 percent)

Aqueous ammonia is ammonium hydroxide in a water solution. It is a colorless liquid with a strong pungent odor used as a nitrogen source for biofuel production, in food processing, and in commercial cleaning compounds (Yara n.d.). It has a relatively low protective action criteria level 2 value, indicating toxicity to inhaled vapors. Aqueous ammonia is not flammable but has a rapid evaporation rate (Table 4-47). Thus, failure of an aqueous ammonia storage tank could result in a significant release of vapors. In a recent evaluation of the impacts of an accidental release of 174,000 gallons (650 cubic meters) of 19-percent aqueous ammonia, DOE determined that the protective action criteria level 2 value of 160 parts per million would be exceeded only within 2,969 feet (900 meters) of the release from evaporation of the pool formed as a result of the accident (DOE 2007b). Since the amount of aqueous ammonia that would be at the biorefinery (30,400 gallons from Table 4-47) is less than one-fifth of the amount analyzed by DOE (DOE 2007b), and the nearest resident is 0.6 mile (1 kilometer), DOE concludes that accidental release of the aqueous ammonia from the biorefinery would not exceed protective action criteria level 2 values for the nearest residents. Thus, DOE does not consider failure of an aqueous ammonia storage tank to have significant potential for adverse offsite health effects.

Workers near an aqueous ammonia spill from tank failure could experience adverse inhalation effects including sore throat, cough, and shortness of breath (Table 4-47).

Lime Silo

Lime silo refers to lime that would be stored in a silo at the biorefinery. Lime is calcium oxide, a chemical powder used in mortar and plaster (Scifun n.d.). Lime is not flammable and has a negligible evaporation rate. Thus, if the lime silo failed, the lime would not be expected to burn or to release toxic vapors. A release of airborne lime particles could occur. These particles could be transported offsite by wind and become available for inhalation by offsite residents. However, the specific gravity of lime is quite high (3.3 to 3.4; ILO 1997b) and therefore particles would be expected to readily deposit out of an airborne plume. Thus, DOE does not consider failure of the lime silo to have significant potential for offsite health effects.

Workers near a failure of the lime silo would likely be exposed to airborne lime powder. Inhalation of the powder could cause a burning sensation, coughing, shortness of breath, and sore throat (Table 4-47).

Corrosion Inhibitor

Corrosion inhibitor refers to a solution of calcium nitrite commonly used to inhibit metal corrosion, particularly in concrete to protect steel reinforcing bars (Woodruff n.d.). Calcium nitrite has a low protective action criteria level 2 value of 0.6 milligrams per cubic meter, indicating high toxicity. However, as indicated in Table 4-47, the amount of corrosion inhibitor would be small [400 gallons (1.5 cubic meters)], the solution is not flammable, and acute inhalation is not expected to result in adverse effects (Grace Construction 2004). Consequently, DOE does not consider failure of the corrosion inhibitor tank to have significant potential for off-site health effects.

Worker exposure to the corrosion inhibitor vapors from a tank failure could result in irritation to the respiratory system (Table 4-47).

Diammonium Phosphate

Diammonium phosphate is used as a fertilizer (Simplot 2009). It is not flammable and has negligible evaporation potential (Table 4-47). It is possible that an explosion near the diammonium phosphate storage tank could cause tank failure and dispersal of some of the chemical as a vapor in the atmosphere. However, the tank would be isolated from other biorefinery facilities (Roach 2009f), and the amount available for release would be relatively small (500 gallons) such that an explosion elsewhere on the site would not be expected to create significant dispersal even if the tank were to fail.

Worker exposure to diammonium phosphate vapors from a tank failure could result in eye and respiratory tract irritation (Table 4-47).

Limestone

Limestone is calcareous rock composed of the mineral calcite (calcium carbonate). It is used for roadbeds, building and landscape construction, and in the manufacture of cement (Minerals Zone n.d.). Limestone is not flammable and has negligible evaporation potential (Table 4-47). It is possible that an explosion near the limestone storage tank could cause tank failure and dispersal of some of the limestone as an aerosol in the atmosphere. The chemical is quite dense [specific gravity of 2.6 to 2.75 (Martin Marietta 2006)], and settling from the atmosphere would be expected to occur in the immediate vicinity of the release. Therefore, no adverse health impacts to the public would be expected from a release. Exposure to workers near the release would be expected to cause irritation of the nose, throat, and respiratory tract, as indicated in Table 4-47.

Sabotage

Whether acts of sabotage or terrorism would occur, and the exact nature and location of the events, or the magnitude of the consequences of such acts if they were to occur is inherently uncertain—the possibilities are infinite. Nevertheless, DOE considered acts of intentional destruction associated with operation of the biorefinery. DOE considers the most hazardous of such acts to be the deliberate destruction of a toxic chemical storage tank. Consequences of such an event are bounded by the toxic chemical tank failures described previously. These consequences would be limited to injury and, in unlikely circumstances, death to nearby workers.

A saboteur could deliberately cause a fire at the biorefinery since combustible chemicals would be stored in bulk. As indicated in Table 4-47, the flammable chemicals that would be stored at the biorefinery include ethanol and gasoline. However, combustion of these chemicals does not produce toxic gases that could pose a threat to offsite members of the public. Burns and adverse effects from inhalation of hot gases could cause injury or death to workers near a fire.

4.12.2 ACTION ALTERNATIVE

The Action Alternative includes a change in the amount of biomass used and elimination of the co-generation capability. Capability would be added to divert some of the biomass to a gasification facility to produce syngas, which would be used in a fire-tube boiler to produce steam. This alternative would not result in any change in the accident impacts involving chemicals presented in Section 4.12.1.1.2 because it would not affect the amount and type of bulk chemicals stored at the site. However, addition of the gasification facility introduces the potential for flammability hazards and release of carbon monoxide from the syngas (a mixture of carbon monoxide and hydrogen). In a recent evaluation of a similar facility designed for coal gasification, DOE determined that the flash fire impact zone from accidental release and ignition of syngas would not have impacts beyond the facility property (DOE 2007b). The impact zone extended less than 200 feet (61 meters) from the point of release. Nearby workers could experience burns and suffocation from the flash fire event. DOE also evaluated the impact of release of carbon monoxide from accidental release of syngas. In this case, DOE found that toxic impacts could result from carbon monoxide exposure extending from 0.4 to 0.6 mile (0.6 to 1 kilometer). This impact could encompass the nearest residence to the biorefinery (0.6 mile). Nearby workers could experience serious health impacts from carbon monoxide exposure.

4.12.3 SUMMARY OF FACILITY ACCIDENTS AND SABOTAGE IMPACTS

DOE concludes that accidents during the operation of the biorefinery are not likely to result in permanent health effects to offsite members of the public. In some accident scenarios, workers could be injured or, in unlikely circumstances, killed depending on the location of the worker at the time of the event.

4.13 Environmental Justice

This section describes the DOE and USDA analysis of *environmental justice* (the potential for impacts to be disproportionately high and adverse to *minority* or *low-income* populations). The region of influence for environmental justice varies with resource and subject area and corresponds to the region of influence for each area. For this EIS, DOE has defined minority and low-income populations as those block groups that have a minority or low-income population 10 percent greater than the proportion of the population of Kansas that is classified as minority (14 percent) and low income (10 percent). The analysis used available 2000 Census data.

4.13.1 IMPACT ASSESSMENT METHODOLOGY

Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," and the associated implementing guidance establish the framework for identification of impacts to low-income and minority populations. The Executive Order directs federal agencies to identify and consider disproportionately high and adverse human health, social, economic, or environmental effects of their actions on minority and low-income communities and American Indian tribes and provide opportunities for community input to the process, which includes input on potential effects and mitigation measures.

DOE performs environmental justice analyses to identify if any high and adverse impacts would fall disproportionately on minority or low-income populations in accordance with guidance from the Council on Environmental Quality. The potential for environmental justice concerns exists if the following occur [quoted from *Environmental Justice Guidance Under the National Environmental Policy Act* (CEQ 1997)]:

> "Disproportionately high and adverse human health effects: When determining whether human health effects are disproportionately high and adverse, agencies are to consider the following three factors to the extent practicable:
>
> a) Whether the health effects, which may be measured in risks and rates, are significant (as employed by NEPA [42 U.S.C. 4321 et seq.]), or above generally accepted

norms. Adverse health effects may include bodily impairment, infirmity, illness, or death; and

b) Whether the risk or rate of hazard exposure by a minority population, low-income population, or Indian tribe to an environmental hazard is significant (as employed by NEPA) and appreciably exceeds or is likely to appreciably exceed the risk or rate to the general population or other appropriate comparison group; and

c) Whether health effects occur in a minority population, low-income population, or Indian tribe affected by cumulative or multiple adverse exposures from environmental hazards.

Disproportionately high and adverse environmental effects: When determining whether environmental effects are disproportionately high and adverse agencies are to consider the following three factors to the extent practicable:

a) Whether there is or will be an impact on the natural or physical environment that significantly (as employed by NEPA) and adversely affects a minority population, low-income population, or Indian tribe. Such effects may include ecological, cultural, human health, economic, or social impacts on minority communities, low-income communities, or Indian tribes when those impacts are interrelated to impacts on the natural or physical environment; and

b) Whether environmental effects are significant (as employed by NEPA) and are or may be having an adverse impact on minority population, low-income populations, or Indian tribes that appreciably exceeds or is likely to appreciably exceed those on the general population or other appropriate comparison group; and

c) Whether the environmental effects occur or would occur in a minority population, low-income population, or Indian tribe affected by cumulative or multiple adverse exposures from environmental hazards."

The DOE analysis of environmental justice for this EIS considered the results of analyses of potential impacts to the different resource areas that focused on consequences to resources that could affect human health or the environment for the general population. In addition, the Department determined if unique exposure pathways, sensitivities, or cultural practices would result in different impacts on minority or low-income populations. If either assessment identified impacts, the environmental justice analysis compared the impacts on minority and low-income populations with those on the general population. In other words, if significant impacts on a minority or low-income population would not appreciably exceed the same type of impacts on the general population, disproportionately high and adverse impacts would be unlikely.

The EIS definition of a minority population is in accordance with the Bureau of the Census racial and ethnic categories.

Analysis of block group data for minority and low-income populations demonstrated several block groups where the minority population exceeded 24 percent and 20 percent, respectively (Chapter 3, Figures 3-22 and 3-23).

Regions of influence, and therefore potentially affected areas, vary with each resource and subject area (Chapter 3, Table 3-1). If there would be no significant impacts in a resource area's region of influence, or if identified significant impacts would not fall disproportionately on low-income or minority populations, there would be no environmental justice impacts. DOE has identified land use, air quality, cultural resources, socioeconomics, health and safety, accidents, and transportation as resources that could be of particular interest to minority or low-income populations. The following sections summarize the impacts to these resource areas.

4.13.2 IDENTIFIED IMPACTS FROM THE PROPOSED ACTION AND ACTION ALTERNATIVE

4.13.2.1 Land Use

Land use impacts from the two action alternatives would be small. The biorefinery crop residue demand would have a negligible impact on changes in land use and would not significantly change the amount of land enrolled in the CRP. Biomass removal in accordance with NRCS guidelines or USDA program rules would not result in a significant adverse impacts, and significant adverse impacts to conservation programs, prime farmland, highly erodible land, or public lands would not be expected. Land use impacts to communities with high percentages of minority and low-income populations within the region of influence would not exceed those of the general population.

4.13.2.2 Air Quality

Air quality impacts from the two action alternatives would be small. Emissions of air pollutants would be below the National Ambient Air Quality Standards for both the Proposed Action and Action Alternative. There are no communities with high percentages of minority or low-income populations that would be impacted by emissions of air pollutants.

4.13.2.3 Hydrology

Surface and groundwater impacts from the two action alternatives would be small. Potential for accidental releases to surface water would be small. The withdrawal rate of groundwater as a result of the two action alternatives would be less than that from the No-Action Alternative. Hydrology impacts to communities with high percentages of minority and low-income populations would not exceed those of the general population.

4.13.2.4 Cultural Resources

Cultural resources impacts from the two action alternatives would be small. There are no National Historic Register sites and there is no indication of a prehistoric or early historic occupation. Cultural resources impacts to communities with high percentages of minority and low-income populations within the region of influence would not exceed those of the general population.

4.13.2.5 Transportation

There would be an estimated 32 traffic fatalities over the life of the project for the Proposed Action and 13 under the Action Alternative as a result of increases in transportation of workers and materials to and from the biorefinery during the construction and operations phases. Impacts from increased transportation to communities with high percentages of minority and low-income populations within the region of influence would not exceed those of the general population.

4.13.2.6 Socioeconomics

Socioeconomic impacts from the two action alternatives would be small. Socioeconomic impacts are driven by changes in population. The increases in population as a result of the Proposed Action and Action Alternative would be small. Socioeconomic impacts to communities with high percentages of minority and low-income populations within the region of influence would not exceed those of the general population.

4.13.2.7 Accidents

In the event of a chemical storage tank failure or other accident, workers would be the most severely impacted, with very little probability of impacts offsite. Members of the public would be offsite and would not be affected by industrial hazards. Thus, there would be no impacts from accidents to the general population. Impacts from accidents to communities with high percentages of minority and low-income populations within the region of influence would not exceed those of the general population.

4.13.3 ENVIRONMENTAL JUSTICE IMPACTS SUMMARY

Impacts to resource areas from the Proposed Action and Action Alternative would be small. Onsite accidents would impact biorefinery workers but would not be expected to impact members of the community. Traffic accidents would increase as a result of increased traffic. No potential impacts to communities with high percentages of minority and low-income populations were identified that would exceed impacts identified for the general population. In addition, during the scoping process, the Department identified no unique exposure pathways, sensitivities, or cultural practices that would result in different impacts on minority or low-income populations. Disproportionately high and adverse impacts would be unlikely as a result of the Proposed Action and Action Alternative.

4.14 No-Action Alternative

Under the No-Action Alternative, DOE would not provide federal funding to Abengoa Bioenergy to support the design, construction, and startup of a biorefinery. For this alternative, DOE assumes that Abengoa Bioenergy would not build the biorefinery and the biorefinery parcel would remain agricultural land. DOE recognizes, however, that Abengoa could pursue alternative sources of capital for the development of the biorefinery.

Under the No-Action Alternative, the site description and descriptions of the affected environment would be the same as depicted in Chapter 3. None of the adverse impacts (for example, emissions of air pollutants, increase in truck traffic and associated increase in accidents and noise) or beneficial impacts (for example, increased employment of up to about 250 workers during construction and 40 workers during operations, infusion of wages into the local economy of up to $17 million per year during construction and $4.4 million per year during operations, decrease in groundwater use, 70-megawatt increase in the electrical production capacity for the region) described in this chapter for the Proposed Action or Action Alternative would occur. Nor would any of the cumulative impacts identified in Chapter 5 occur.

Furthermore, the benefits that would be gained from the development, demonstration, and commercial operation of an integrated biorefinery that uses lignocellulosic feedstocks would not be realized. In addition, no benefits would be realized from the development of a renewable energy system that would reduce air pollutants and emissions of greenhouse gases. For example, the reduction in greenhouse gas estimated to occur if the Proposed Action was implemented would not be realized with the continued use of gasoline instead of biofuel and no generation of biopower.

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Chapter 5

Cumulative Impacts

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5. CUMULATIVE IMPACTS

In preparing this chapter, the U.S. Department of Energy (DOE or the Department) followed the Council on Environmental Quality regulations that implement the procedural provisions of the *National Environmental Policy Act* (NEPA; 42 U.S.C. 4321 et seq.), as well as guidance provided in *Considering Cumulative Effects Under the National Environmental Policy Act* (CEQ 1997). The Council on Environmental Quality regulations define a *cumulative impact* as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and *reasonably foreseeable* future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions" (40 CFR 1508.7). The Council's guidance notes that "cumulative effects must be evaluated along with the direct effects and indirect effects (those that occur later in time or farther removed in distance) of each alternative [and] the range of actions that must be considered includes not only the project proposal but all connected and similar actions that could contribute to cumulative effects."

REASONABLY FORESEEABLE

Refers to future actions for which there is a reasonable expectation that the action could occur, such as a proposed action under analysis by a state or federal agency, a project for which construction has started, or an action that has obtained the necessary regulatory approvals or has funding committed to the action.

Based on the above, DOE identified actions that could have effects (impacts) that coincided in time and space with the effects from the *biorefinery* and associated transportation activities. The Department based its identification of relevant actions on interviews with representatives of local government and associated economic development organizations (such as the Stanton County Chamber of Commerce and Economic Development, Kansas), elected officials (such as the County Commission for Baca County, Colorado) and community business members (Centera Bank in Satanta, Kansas); reviews of published resource, policy, land use and other plans from agencies at all levels of government [for example, the Kansas Department of Transportation and U.S. Department of Agriculture (USDA) Forest Service Cimarron National Grasslands]; reviews of published media accounts (Grant County Gazette, Kansas); and interviews with private organizations (Nexsun LLC).

Reasonably foreseeable future actions were identified in the area within 50 miles (80 kilometers) of the *Biorefinery Project site* (Figure 5-1). In a few instances, potential actions that appeared to be reasonably foreseeable, yet would be located outside but relatively close to the *region of influence*, also were considered for detailed evaluation.

This chapter is organized as follows:

- Section 5.1 presents past, present, and reasonably foreseeable future actions. This section includes a description of the expansion of the proposed biorefinery to include a grain-to-ethanol facility that would produce about 88 million gallons (330 million liters) of denatured ethanol per year, a truck bypass route to be constructed in Hugoton, a proposed ethanol and biodiesel facility in Grant County, Kansas, and other foreseeable future actions.

- Section 5.2 presents the incremental (relative to the *Proposed Action* and Action Alternative) and cumulative environmental impacts from the addition of the grain-to-ethanol facility. The analysis focuses on those resource areas for which the addition of the grain-to-ethanol facility would result in

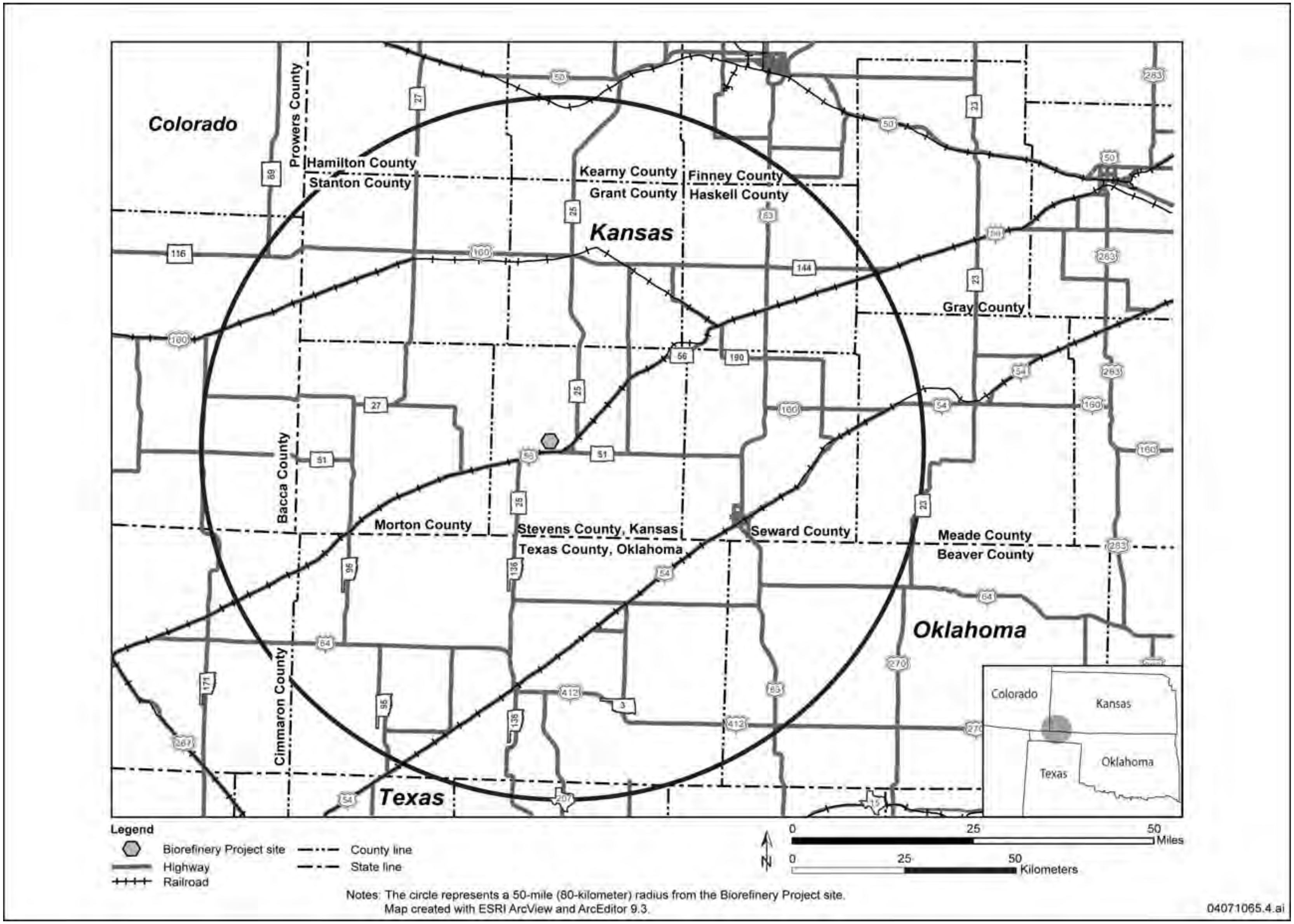

Figure 5-1. Biorefinery Project site showing the 50-mile (80-kilometer) region of influence.

more meaningful cumulative impacts. As an example, impacts (see Chapter 4) to biological and *cultural resources* and to soils would be very small under the Proposed Action and Action Alternative. In addition, disproportionately high and adverse impacts to *low-income* and *minority* populations are not likely. Further, cumulative impacts to these resource areas from the addition of the grain-to-ethanol facility likely would not change in a meaningful way (impacts would still be considered to be very small), and therefore, these resource areas and *environmental justice* considerations are not addressed further in this chapter.

- Section 5.3 presents the incremental (relative to the grain-to-ethanol facility, the Proposed Action, and Action Alternative) and cumulative environmental impacts from all other reasonably foreseeable future actions.

5.1 Past, Present, and Reasonably Foreseeable Future Actions

This section presents past, present, and foreseeable future actions with impacts that could combine with those of the Proposed Action and Action Alternative.

5.1.1 PAST AND PRESENT ACTIONS

The description of existing environmental conditions in Chapter 3 includes the impacts of past and present actions on the environment that the Proposed Action and Action Alternative would affect. For this reason, the Chapter 4 analyses of potential environmental impacts of the Proposed Action and Action Alternative generally encompass the impacts of past and present actions.

5.1.2 REASONABLY FORESEEABLE FUTURE ACTIONS

This section describes reasonably foreseeable future actions, first the expansion of the proposed biorefinery to include the capability to convert grain-to-ethanol, and then other projects in the region of influence.

5.1.2.1 Grain-to-Ethanol Facility

As described in Chapter 2 of this Abengoa Biorefinery Project EIS, the biorefinery would use *biomass feedstock* to produce ethanol, *lignin*, ash (soil amendment), heat, and electricity. In January 2009, Abengoa Bioenergy informed DOE that it was no longer considering the construction and operation of a traditional grain-to-ethanol facility because of economic viability and anticipated market conditions. Abengoa has, however, continued to develop its plans and facility design to enable the addition of a grain-to-ethanol facility after construction of the biorefinery.

The grain-to-ethanol facility would operate independently of the biorefinery, although certain then-existing biorefinery systems would be used as described below. The grain-to-ethanol facility would produce about 88 million gallons (330 million liters) of denatured ethanol based on a 350-day annual operating schedule (Roach 2009a).

The traditional grain-to-ethanol facility would utilize approximately 31 million bushels (790,000 metric tons) of grain (corn, sorghum, wheat) purchased from area farmers and from producers in the Midwest. Solids from the process would be converted to animal feed, which would result in the production of up to 782,000 tons (709,000 metric tons) per year of wet distiller's grains with solubles. The facility would have the capability to dry up to 50 percent of the wet distiller's grains, producing a maximum of 152,000 tons (138,000 metric tons) per year of dried distiller's grains with solubles (Roach 2009b).

The grain-to-ethanol process comprises the following major production steps/areas:

- Onsite grain receiving, storage, and milling;
- Grain *fermentation* and *distillation*;
- Wet distiller's grains with solubles drying, and storage and loadout of the dried distiller's grains with solubles;
- Wet distiller's grains with solubles storage and loadout;
- Production storage tanks; and
- Steam generation.

The following then-existing systems would be utilized and/or upgraded to accommodate the addition of the grain-to-ethanol process:

- Production piping system and loadout;
- Utilities (for example, wastewater treatment, cooling tower, chilled water, and compressed air); and
- Emergency equipment.

5.1.2.1.1 *Grain Receiving, Storage, and Milling*

The grain handling operations would involve unloading grain from trucks or railcars, storage silos, grain elevators, and associated conveyors. Grain would be received at the facility in 25-ton (23-metric-ton) hopper bottom trucks or railcars at a combined pit for trucks and railcars located inside an enclosed building. The pit would be fitted with conveyor belts to feed the elevator and grain storage silos. Fabric filter dust collectors (baghouses) would control particulate emissions from the pit and associated grain transfer points.

The grain milling operations would include a surge bin, grain elevator, one scalper, four hammermills, and associated conveyors. In the milling process, a grain transfer conveyor would feed grain from the grain storage silos to the scalper, which would remove unusable debris from the grain. The discharge conveyor from the scalper would transfer the scalped grain to the hammermills, where the scalped grain would be reduced in size to a powdered "meal." The ground grain would be transferred to the slurry tank, which marks the beginning of the fermentation process. Particulates and airborne debris from each hammermill, the surge bin, and scalper would be controlled by baghouses. The solids collected in the baghouses would be returned to the process downstream of the hammermills.

The grain receiving system would, in general, be a closed system with high-velocity pickup of particles; overhead doors, however, may not be closed at all times and therefore a capture efficiency of 95 percent is anticipated. The grain conveying, storage, and hammermilling operations would have a 100-percent capture efficiency based on the design and operational use of baghouses.

5.1.2.1.2 *Grain Fermentation and Distillation*

Grain fermentation and distillation operations would include a slurry tank, yeast tank, conversion and liquefaction tank, pre-fermenter tanks/vessels, fermenter tanks, beer well, various columns, molecular sieves, centrifuges, whole stillage tank, syrup tank, thin stillage tank, waste heat evaporator, finish evaporator, and scrubbers.

Milled grain would be transferred from the hammermills to a surge bin (ground corn bin) where a conveyor would transfer the milled grain to the mash mixer. The mash mixer would mix the grain with hot water from the hot well and recycled process water from the stripper column and evaporators to form slurry. The slurry would then be discharged by gravity from the mash mixer to a slurry tank, which would provide surge capacity in the cooking system, allowing for pre-liquefaction of the starch, and if necessary, viscosity control. In addition, *caustic* or *anhydrous* ammonia would be added for pH control, as required.

The slurry would be heated to liquefy and break down the starch to sugars. Backset (thin stillage recycle) or sulfuric acid may be added to the mash to lower the pH. The slurry would then be cooled and sent to fermenter process vessels. Saccharifying enzymes, nutrients, and industrial antibiotics would be added to the fermenter. The saccharification enzyme completes the conversion of starch to fermentable sugar, and the yeast converts the fermentable sugar to ethanol and carbon dioxide.

The fermented mash, called “beer” contains about 10-percent ethanol by weight, 90-percent water, and leftover solids from grain and yeast. When fermentation is complete, the beer would then be transferred to the beer well via the fermenter pumps.

The carbon dioxide generated from the pre-fermenter would pass through the pre-fermentation vent scrubber, and the carbon dioxide generated from the fermenters and the beer well would pass through the main fermentation vent scrubber. These wet scrubbers allow for ethanol vapors to be collected and processed to produce a higher product yield, and also provide emissions control for volatile organic compounds and hazardous air pollutants (such as acetaldehyde, methanol, acrolein, and formaldehyde). The water from these wet scrubbers would be pumped back into the process for recycling. Carbon dioxide would be captured from the main fermentation vent scrubber and pumped via pipeline to an offsite party for use in enhancing the amount of crude oil that can be recovered from existing oil fields (no additional details specific to the grain-to-ethanol facility are available). Carbon dioxide injected into a depleted oil *reservoir* with suitable characteristics can enhance oil recovery. In addition to the beneficial oil recovery, the carbon dioxide *sequestration* would reduce emissions of *greenhouse gases* from the grain-to-ethanol facility and qualify the ethanol produced as advanced biofuel.

The beer well is a process tank that would provide a continuous flow of beer slurry to the distillation column in which ethanol would be separated from the residual grain solids and water. The remaining grain solids, known as stillage, would be sent to the whole stillage tank to be further processed for use as cattle feed. The water would be recycled in the process.

The ethanol would be separated from the beer by distillation and leave the distillation section as 90 percent by weight. Ethanol vapor from distillation would be drawn and superheated using steam. The superheated ethanol vapor would flow through molecular sieve units in a process known as dehydration to increase the ethanol to 98 percent by weight.

Stillage from the whole stillage tank would be pumped to stillage centrifuges. The stillage centrifuges would split the feed into two flows: the wet cake and thin stillage. The water content of the stillage would be reduced further to make “syrup.” The wet cake would be mixed with the syrup to become wet distiller’s grains with solubles and would be discharged onto a conveyor to transfer the wet cake to a storage area or to the drying area (evaporation system), where it would become dried distiller's grains with solubles.

Vent emissions from the evaporators would be equipped with vent condensers to control emissions (estimated control efficiency of 98 percent, which is equivalent to best available control technology). When the distiller’s grain is dried, volatile organic compounds and hazardous air pollutants are produced and would be burned off.

Vapors from the distillation area would flow through the distillation vent scrubber, which would allow the collection of ethanol vapors for further processing to improve product yield. The vent scrubber also would provide control of volatile organic compounds and hazardous air pollutants. Water from this wet scrubber would be pumped into the beer well for recycling back into the process.

5.1.2.1.3 *Storage and Loadout*

Dried distiller’s grains with solubles would be stored in a building until it is shipped offsite by truck and/or rail for use as cattle feed. The dried distiller’s grains with solubles would be loaded into trucks or railcars within an enclosure. Given the size of the storage building and the minimal amount of *fugitive dust* that would be emitted from this process, it is not feasible to control fugitive dust using a baghouse system or other add-on control device. Therefore, building openings and ventilation would be kept to a minimum consistent with required operations and good industry safety and health practices. In contrast to typical practices in which loadout is undertaken in the open, the loadout system, in general, would be a closed system with high-velocity pickup of particles that would be collected in a baghouse.

The wet cake would be stored on a concrete pad in an open storage area and then loaded onto trucks for delivery to cattle feedlots in the vicinity of the facility or transferred to the drying process. The wet cake might not be transferred offsite for up to two days and would not dry in the event of extreme weather. Therefore, wet cake storage and handling is expected to produce emissions of *particulate matter*, volatile organic compounds, and hazardous air pollutants (the latter two are produced as the wet cake dries in storage).

5.1.2.1.4 *Storage Tanks*

The grain-to-ethanol facility includes two shift tanks, one off-specification tank, and three production storage tanks. Each shift tank would have a capacity to store 150,000 gallons (568,000 liters) of anhydrous ethanol (product). The off-specification tank also would have a capacity of 150,000 gallons and would contain anhydrous ethanol that does not meet the required specifications (this ethanol would be reprocessed or blended into the process to produce in-specification ethanol).

Prior to shipping the fuel-grade ethanol out of the facility, the ethanol would be combined with a maximum 4.9-percent gasoline and stored in one of three 1-million-gallon (3.8-million-liter) tanks. Denaturant (gasoline) to be blended with the ethanol prior to shipping would be stored in a separate 150,000-gallon (568,000-liter) tank.

Product loading consists of submerged loading of gasoline (denaturant) and denatured ethanol to and from tanker trucks and tanker railcars. The emissions from the tanker truck and railcar loadout would be collected by a vapor recovery system then routed to a carbon adsorption hydrocarbon vapor recovery system. About 98 percent of the emissions would be captured by the carbon adsorption system.

Each tank would utilize an *internal floating roof* to inhibit emissions of volatile organic compounds. Storage tanks would be enclosed in a bermed area to retain any spills that could occur. A corrosion inhibitor storage tank injection system also would be installed.

5.1.2.1.5 *Steam Generation*

Steam would be generated in the four parallel natural gas-fired boilers. Parallel gas-fired boilers were selected to increase steam supply reliability. For example, in the event one boiler goes out of service, there would be sufficient steam production from the remaining boilers to maintain the grain-to-ethanol operations.

5.1.2.2 Truck Bypass

Stevens County has identified a need to construct a bypass around the city of Hugoton to facilitate truck traffic to and from the proposed biorefinery (Stevens County 2008). The County would use the existing road network, but would upgrade the quality of the roads by improving its base and adding an asphalt layer sufficient to accommodate anticipated truck and other vehicular traffic during operation of the biorefinery. The bypass would depart from Kansas State Highway K-25 about 1 mile (1.6 kilometers) north of the Hugoton city limits, head west about 1 mile on Road Q to Road 12, then proceed another mile south to Road P, turn west for about 4 miles (6 kilometers) to Road 10, at which point the bypass would turn south to connect with U.S. Highway US-56/K-51 (see Figure 5-2). Stevens County intends to complete construction of the bypass by the start of biorefinery operations.

5.1.2.3 Nexsun Ethanol and Biodiesel Facility

On January 22, 2007, Nexsun Ethanol LLC, an affiliate of Nexsun Energy, announced its plan to develop, in two phases, an integrated biorefinery in Ulysses, Kansas (Nexsun n.d.). The first phase of the project would be a 44-million-gallon (170-million-liter) per year ethanol production facility that also would produce about 455,000 tons (413,000 metric tons) per year of wet distiller's grains and associated “syrup” that would be sold for animal feed. Like other ethanol facilities, the Nexsun facility would emit carbon dioxide that would be released to the atmosphere, as well as other volatile organic compounds and hazardous air pollutants. Locally grown milo and corn would be procured as the grains of choice for the production of ethanol (Hussmann 2009).

The second phase of the project would be a 3-million-gallon (11-million-liter) per year biodiesel plant at an adjacent location. Biodiesel would be produced from commercially available tallow and yellow grease (grease from restaurants and other similar sources) (Hussmann 2009).

The site comprises approximately 94 acres (0.4 square kilometers). To date, Nexsun Ethanol LLC has purchased the land, initiated site preparation, and completed an onsite railroad system (a rail spur connecting the site to the Cimarron Valley Railroad is anticipated). The site has been graded and otherwise prepared for construction, and temporary underground utilities and a fire suppression system

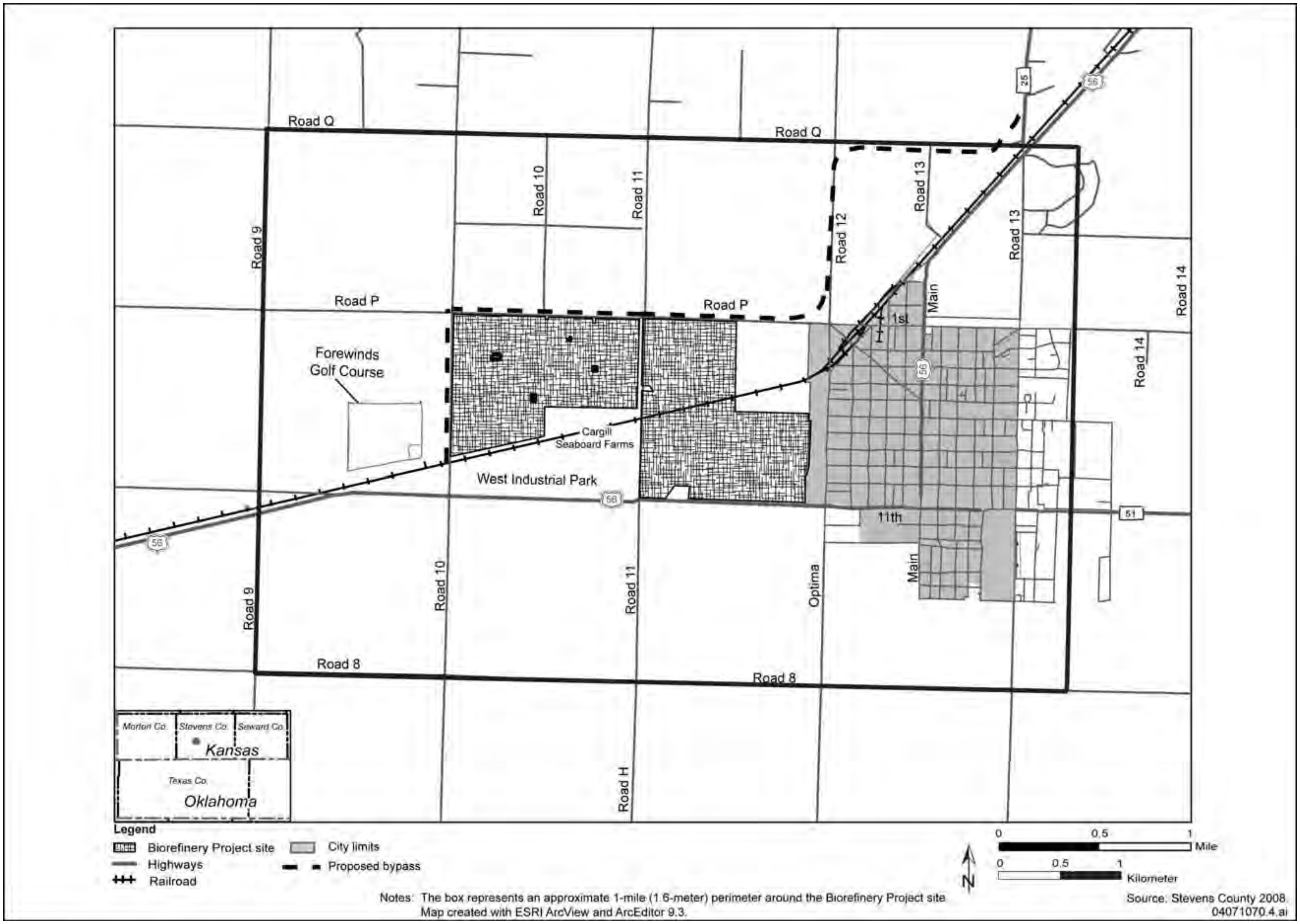

Figure 5-2. Biorefinery Project site showing the truck bypass.

have been installed. Nexsun Ethanol LLC would obtain its process and potable water from the City of Ulysses; electricity and natural gas would be obtained through commercially available sources. The schedule to complete construction and begin operations is not known. An operations workforce of 54 is anticipated (Spooner 2009).

5.1.2.4 Tallgrass Transmission Project

The Tallgrass Transmission, LLC project is a joint venture formed by OG&E Energy Corporation and Electric Transmission America (a joint venture of subsidiaries of American Electric Power and MidAmerican Energy Holdings Company) (Tallgrass n.d.). The joint venture would construct transmission lines in western Oklahoma to facilitate the development and transmission of wind-generated electricity. The project includes construction of two segments of 765-kilovolt transmission lines originating from the Woodward, Oklahoma area: a 50-mile (80-kilometer) segment from Woodward, north to the Kansas border, and a 120-mile (190-kilometer) segment extending from Woodward to the vicinity of Guymon, Oklahoma (Figure 5-3). The 120-mile segment would extend into the region of influence for this Abengoa Biorefinery Project EIS.

The Federal Energy Regulatory Commission approved incentive-based rate treatments for the Tallgrass Transmission, LLC project on December 2, 2008 (Docket No. ER09-35-000), indicating progress toward project implementation (FERC 2009). Specific details of project scheduling are not readily available; however, project descriptions provided by the parties involved suggest work on the 120-mile (190-kilometer) segment could begin in the second half of 2009, construction could be completed in 2012, and transmission would be online by 2013 (Tallgrass n.d.). Tallgrass Transmission, LLC intends to solicit input from landowners and communities along the planned route, negotiate with landowners to secure necessary rights-of-way, and define a specific route prior to construction.

5.1.2.5 Transportation Infrastructure Improvements

The Departments of Transportation for the states of Kansas, Oklahoma, and Colorado maintain plans for transportation system infrastructure improvements. For instance, in Texas County, Oklahoma, there are four projects planned for 2009, three projects in 2011, and two projects in 2012; there are no such projects planned in other counties within the region of influence (Cimarron and Beaver counties) in Oklahoma (ODOT 2009). In Kansas, three projects are planned for Seward County and one for Morton County (KDOT 2009). These projects typically involve a range of actions including improvements to grade and drainage, road widening over relatively short distances, removal and replacement of damaged road surfaces (resurfacing), improvements to railroad crossings, and development of a rest area.

Although DOE considers these infrastructure improvement projects to be reasonably foreseeable, it is uncertain when each project would be undertaken. To illustrate, one project in Morton County originally was proposed to be undertaken in 2002 and one in Seward County was proposed to be undertaken in 2005. In addition, little information is available regarding how, and under what conditions, construction would proceed.

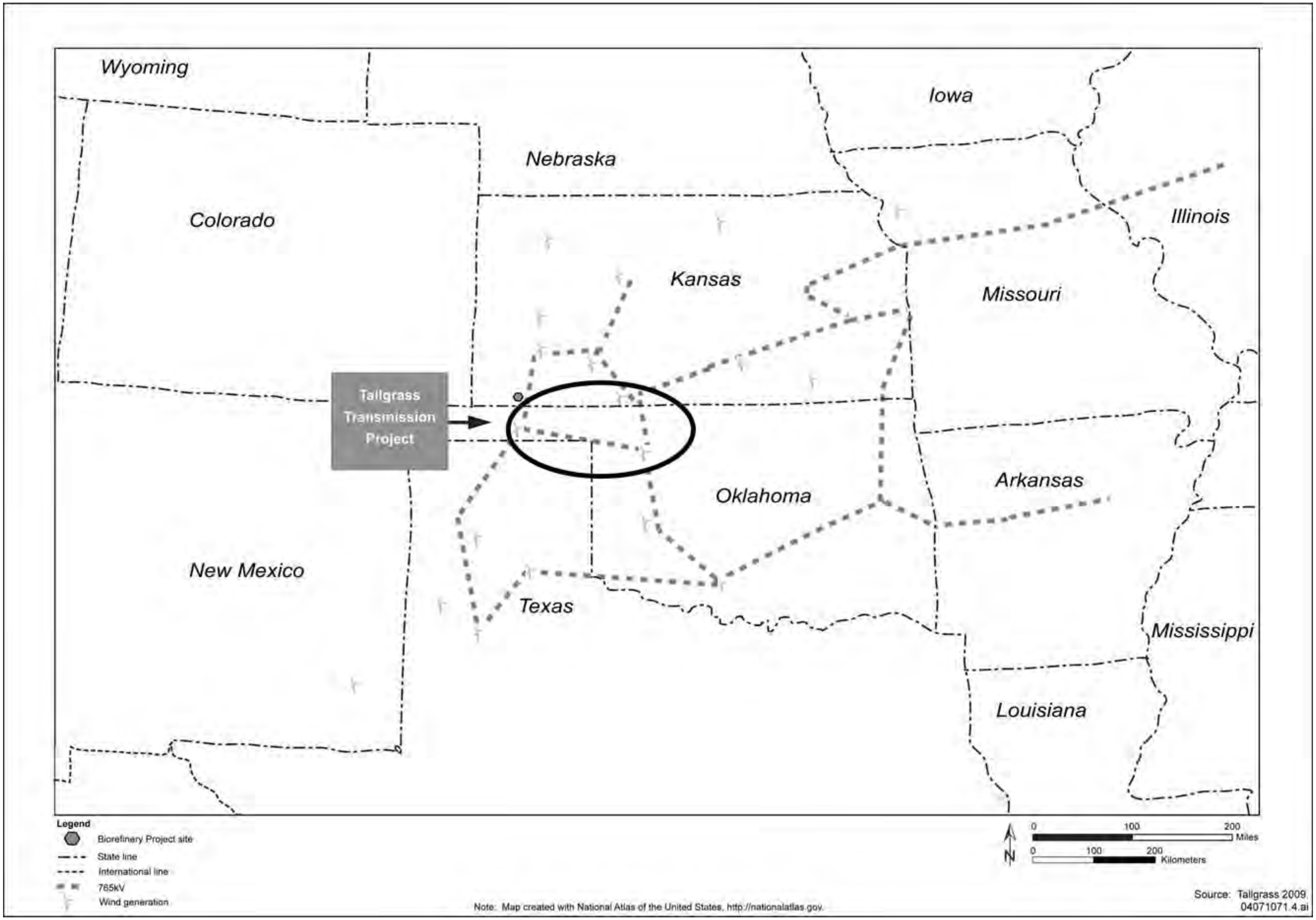

Figure 5-3. Tallgrass Transmission, LLC Project.

5.1.2.6 USDA Biomass Crop Assistance Program

The *Food, Conservation, and Energy Act of 2008* (2008 Farm Bill) created the Biomass Crop Assistance Program. This program is managed by the Business and Cooperative Programs, an agency in the Rural Development mission area of the USDA. The purpose of this program is to support the establishment and production of crops for conversion to bioenergy and assist with collection, harvest, storage, and transportation of eligible material for use in a biomass conversion facility. In general, agricultural producers in project areas would receive a payment of up to 75 percent of established costs. Also, USDA would match dollar-for-dollar what the biomass collector (whether the farmer or some other person) is paid by the biomass user facility for collection, harvest, storage, and transportation to the biomass conversion facility, up to $45 per dry ton.

Agricultural producers may apply to the USDA for eligibility to the Biomass Crop Assistance Program by providing a description of the land and crops and their associated location (project area), and a letter of commitment from a biomass conversion facility stating that the facility will use these crops or evidence that the facility has sufficient equity available, if the facility is not operational at the time the proposal is submitted by the producer. The USDA will evaluate proposals for eligibility based on various criteria, including:

- The volume of the eligible crops proposed to be produced and the probability that such crops will be used under program rules;
- The volume of renewable biomass projected to be available from sources other than the eligible crops grown on contract acres;
- The anticipated economic impact in the proposed project area;
- The opportunity for producers and local investors to participate in the ownership of the biomass conversion facility in the proposed project area;
- The participation rate by beginning or socially disadvantaged farmers or ranchers;
- The impact on soil, water, and related resources;
- The variety in biomass production approaches within a project area, including agronomic conditions, harvest and post-harvest practices, and mono- and polyculture crop mixes; and
- The range of eligible crops among project areas.

On September 4, 2008, the USDA Rural Business-Cooperative Service held a public meeting to gather public comments and suggestions on how to implement authorities related to expanding rural renewable energy opportunities authorized under Title IX of the 2008 Farm Bill. The USDA is in the process of developing program rules to implement the requirements of Title IX.

The USDA Commodity Credit Corporation is preparing a programmatic EIS for the implementation of the Biomass Crop Assistance Program. The Farm Service Agency, which administers the Program on behalf of the Corporation, initiated public scoping for the EIS in May 2009 and solicited public input about potential alternatives to implement the Program. The draft programmatic EIS was issued for public comment on August 7, 2009 (74 FR 39698).

At this time, there is insufficient information available for DOE to assess potential cumulative impacts from the implementation of the Biomass Crop Assistance Program. Even so, the Department has identified the program as a reasonably foreseeable future action because of the potential for cumulative impacts to occur during the lifetime of the biorefinery under either the Proposed Action or Action Alternative, and because information regarding the program rules may become available in the relatively near future.

5.2 Cumulative Impacts from Grain-to-Ethanol Facility

This section describes the potential incremental impacts (relative to the Proposed Action and the Action Alternative) from the addition of the grain-to-ethanol facility.

5.2.1 LAND USE

5.2.1.1 Grain-to-Ethanol Construction Relative to Proposed Action

5.2.1.1.1 *Biorefinery Portion of the Project Site*

The addition of the grain-to-ethanol facility would expand the "footprint" of the 385-acre (1.6-square-kilometer) *biorefinery area*. However, the biorefinery area would be zoned Heavy Industrial District with or without the grain-to-ethanol facility. Therefore, construction of the grain-to-ethanol facility would be consistent with planned zoning.

DOE is not aware of any beneficial use of unused portions of the area under the Proposed Action that would be impacted by construction of the grain-to-ethanol facility. Therefore, increasing the relative size of the biorefinery area would not be anticipated to result in a cumulative impact to land use on the area.

5.2.1.1.2 *Buffer Area Portion of the Project Site*

Under the Proposed Action, the 425-acre (1.7-square-kilometer) *buffer area* would remain in agricultural use and zoned Agricultural District. Construction of the biorefinery under the Proposed Action would not result in a change in land use for the buffer area. Likewise, DOE is not aware of any grain-to-ethanol facility construction parameters that would result in a change in land use for the buffer area.

5.2.1.1.3 *Offsite*

As Chapter 4, Section 4.1 describes, construction of the biorefinery under the Proposed Action would result in minor land use impacts associated with infrastructure improvements and development. Infrastructure-related impacts, such as improvements to roads or installation of utility supply lines, would be confined generally to existing transportation and utility corridors. The associated minor impacts are related to short-term loss of use during construction.

5.2.1.2 Grain-to-Ethanol Operations Relative to Proposed Action

5.2.1.2.1 *Biorefinery Portion of the Project Site*

Operation of the grain-to-ethanol facility would not result in cumulative land use impacts on the biorefinery parcel.

5.2.1.2.2 *Buffer Area Portion of the Project Site*

Operation of the grain-to-ethanol facility would result in a relatively small change in land use on the buffer area relative to the Proposed Action, as there would be an increase in the amount of non-contact wastewater disposed of on the buffer area through the existing irrigation system. Application of the additional wastewater would require a permit from the Kansas Department of Health and Environment.

5.2.1.2.3 *Offsite*

The primary potential cumulative offsite impact to land use from operation of the grain-to-ethanol facility is related to feedstock demand. The grain-to-ethanol facility would require 31 million bushels (790,000 metric tons) of grain per year. This demand represents a potential incentive for land use change within the region of influence. Grain feedstock demand could prompt changes in land use through conversion of non-cropland to cropland or a change in the management of cropland. Accordingly, DOE evaluated land use impacts by evaluating potential conversion and cropland management changes.

To evaluate land use change relative to feedstock demand, a general model of land use change is needed. For this, DOE relied on the following from *Increasing Feedstock Production for Biofuels* (BRDB 2008):

- While individual agricultural markets (such as corn) have proven very responsive to new sources of demand, substantial increases in the production of one crop generally come at the expense of another.
- Additional corn acreage tends not to come from uncultivated or marginal land.
- Growers may also switch rotation patterns, growing corn 2 or more years in a row rather than alternating crops.
- Land that is currently not cultivated for crops (pasture or marginal land) is likely to be less productive than existing cropland due to climatic and agronomic factors.
- Converting *Conservation Reserve Program* (CRP) land, native *grasslands*, and other lands in less intensive uses could reduce wildlife habitat and increase delivery of sediment, nutrients, and pesticides to water bodies.
- This additional cropland will come primarily from cultivated farmland currently used for other crops, so this shift is expected to involve minimal environmental changes.

These general statements made within the context of land competition and land use change analysis imply a general model of land use change induced by an increasing demand for *biofuels* (primarily corn). The general model is that changes in land use management are followed by land use conversion. First, producers make a change in management on existing farmland to increase production of the crop in demand. Initially, the increased production is likely to come from a change in *crop rotation* patterns or cropping practices that increase yield. A substantial increase in the production of one crop generally comes at the expense of another, but this shift involves minimal environmental change. Eventually, land in less-intensive use is converted to cropland. This change in land use type is considered to have an adverse impact on the environment.

This qualitative land use change model was used to assess changes in grain and *cellulosic feedstock* production, changes in soil conditions, and impacts to conservation programs.

Corn

Corn would comprise approximately 30 percent of the feedstock for the grain-to-ethanol facility. As Chapter 3, Section 3.1.1.2 discusses, recent corn production within the 50-mile (80-kilometer) region of influence was almost 100 million bushels (2.5 million metric tons) per year. The grain-to-ethanol facility is expected to consume approximately 9.7 million bushels (250,000 metric tons) per year of corn, 7 million bushels (180,000 metric tons) per year from areas outside the region of influence, and 2.7 million bushels (70,000 metric tons) per year from local sources. The amount of local corn anticipated to be consumed annually by the grain-to-ethanol facility is in the range of 2 to 3 percent of recent corn production. DOE does not expect demand representing such a low portion of production to result in noticeable land use changes relative to existing corn production.

Grain Sorghum

Grain sorghum would comprise approximately 70 percent of the feedstock for the grain-to-ethanol facility. Approximately 13.5 million bushels (340,000 metric tons) of grain sorghum were produced in 2007 within the seven nearby counties. These same seven counties have produced as much as 16 million bushels (410,000 metric tons) within the last five years. If extrapolated to the entire region of influence, 21 million bushels (530,000 metric tons) of grain sorghum could be produced. These data indicate that under conditions independent of the grain-to-ethanol facility, grain sorghum production has approached the anticipated grain-to-ethanol demand of 21.3 million bushels (540,000 metric tons). The grain sorghum is typically marketed locally and then shipped by railroad to the terminal elevators and markets to the east (NRCS 2006).

Current production that is mainly shipped outside the region of influence meets a large portion of the grain-to-ethanol facility demand. Over time, it is expected that the amount of grain sorghum produced within the region of influence would increase to meet this demand. Accordingly, Abengoa Bioenergy's grain procurement strategy indicates the initial shortage of grain sorghum would be replaced with corn shipped in by unit train directly from producing areas outside the region of influence. As production of grain sorghum increased in response to demand within the region of influence, there would be a general change in land use. Using the general land use change model, the increased production would come from changes in land use management. Considering the relatively small shortage of grain sorghum in relation to *total cropland* within the region of influence, the increased grain sorghum production would most likely come from existing cropland and not result in conversion of less-intensive lands to cropland.

Lignocellulosic Feedstock

The grain-to-ethanol facility would not change lignocellulosic feedstock demand of the biorefinery, so lignocellulosic feedstock demand impacts would be unchanged relative to the Proposed Action. Considering the excess lignocellulosic feedstock within the region of influence and the capacity of the biorefinery to utilize different types of *lignocellulosic feedstocks*, a minor increase in grain sorghum production at the expense of other crops is not anticipated to have an adverse cumulative impact on lignocellulosic feedstock availability.

Cropping Practices

Increased grain sorghum production would have an impact on cropping practices to the extent needed to meet grain sorghum demand. As presented in Chapter 3, Section 3.1.1.2.1, the existing conditions are dynamic. DOE does not consider, however, the increased grain sorghum demand to be sufficient to induce significant adverse impacts to conservation-related cropping practices. Short-term changes in cropping practices likely would involve changes in crop rotations and crop inputs to increase yield. The long-term change would be a shift in grain sorghum production at the expense of other crops currently grown on cropland.

Soil Conditions

DOE does not anticipate the grain-to-ethanol facility would have a noticeable cumulative impact on soil conditions. Increased grain sorghum production at the expense of another crop is not expected to noticeably change soil conditions.

Conservation Programs

DOE anticipates that cumulative impacts to conservation programs would be negligible because feedstock demand is not anticipated to result in land use conversion. In addition, federal programs provide many incentives to practice sustainable farming methods and participate in conservation programs.

5.2.1.3 Grain-to-Ethanol Relative to the Action Alternative

For land use, the cumulative impact of the grain-to-ethanol facility relative to the biorefinery under the Action Alternative is nearly identical to those cumulative impacts under the Proposed Action. Cumulative infrastructure and development impacts on land use are anticipated to be small. The increased water supply demand of the grain-to-ethanol facility would impact use of the land from which the additional water rights were obtained. Since the amount and type of irrigated cropland converted to dry-farmed cropland relative to the amount within the region of influence would be small, the cumulative impact would still be small. The Action Alternative demands roughly 30 percent of the lignocellulosic feedstock as the Proposed Action, but the grain-to-ethanol facility has no significant cumulative impact on lignocellulosic feedstock demand or procurement.

5.2.2 AIR QUALITY

This section describes the cumulative impacts to *air quality* from the air emissions from construction and operation of the biorefinery (Proposed Action, Action Alternative) and the grain-to-ethanol facility. Cumulative impacts to air quality during construction of the grain-to-ethanol facility and during operations under the Proposed Action and Action Alternative are discussed in Section 5.2.2.1.

Sections 5.2.2.2 and 5.2.2.3 provide estimates of the cumulative impacts to air quality from operation of the biorefinery and grain-to-ethanol facility under the Proposed Action and Action Alternative, respectively. The air dispersion model used to estimate these impacts involves mathematical simulations of the interactions of air pollutant sources, physical structures of the involved facilities, and various types of data. Determining impacts to air quality from the biorefinery and grain-to-ethanol facility requires a "combined" air dispersion analysis, and therefore, unlike most other resource areas in this Chapter, it is not feasible to present the incremental impact of the addition of the grain-to-ethanol facility (in other words, the cumulative impact to air quality is not the simple sum of the impacts under the Proposed Action or Action Alternative plus those of the grain-to-ethanol facility).

5.2.2.1 Grain-to-Ethanol Construction

Construction of the grain-to-ethanol facility would occur while the biorefinery under the Proposed Action or Action Alternative is in operation. Construction of the grain-to-ethanol facility would create emissions from various activities including the use of heavy diesel-powered equipment, disturbance of the soil, grading activities, material transport, and material handling. These activities would generally be short term or intermittent in nature. Dust generating activities would be undertaken in concert with *best management practices* including watering to stabilize disturbed areas, limiting activities in areas not being accessed during construction, limiting the number of site access points, and staging construction activities to avoid multiple dust-generating activities from occurring simultaneously (Chapter 7, Table 7-1 provides additional detail). Further, the use of well-maintained construction equipment having appropriate emissions controls would reduce tailpipe emissions from diesel-powered heavy machinery. For these reasons, the cumulative impacts to air quality resulting from emissions during construction of the grain-to-ethanol facility would be slightly greater than the air quality impacts that would occur only due to the operation of the Proposed Action or Action Alternative.

5.2.2.2 Grain-to-Ethanol Operations Relative to Proposed Action

Operation of the biorefinery with the addition of the grain-to-ethanol facility would result in an increase of regulated air pollutants as well as greenhouse gases relative to those described under the Proposed Action (Chapter 4, Section 4.2.1.2). A summary of the emission sources from the biorefinery and grain-to-ethanol facility by source group (equipment and processes) and the expected emissions from each source group are listed in Table 5-1. The grain-to-ethanol facility would involve additional processes relative to those of the biorefinery that would result in air emissions including, grain handling and milling, grain fermentation and distillation, and the production of dried distiller's grains with solubles and wet distiller's grains with solubles. In addition, the grain-to-ethanol facility would increase the production of denatured alcohol (from 18 millions gallons [68 million liters] per year to 114 million gallons [432 million liters] per year), which would result in a corresponding increase in air emissions from the storage tanks and denatured ethanol loadout. Fugitive emissions from onsite haul roads also would increase due to increased receiving and loadout traffic. Lastly, the grain-to-ethanol facility would require steam production separate from that of the Proposed Action, and, therefore, additional boilers would be required. Table 5-2 lists the emission summary for the Proposed Action with the grain-to-ethanol facility, both with and without proposed controls in place for the two possible operational scenarios (Roach 2009c). The grain-to-ethanol facility would have the capability to dry up to 50 percent of the wet distiller's grains. Thus, the two possible operational scenarios considered for analysis were the scenario without any drying of the wet distiller's grains, and the scenario with drying 50 percent of the wet distiller's grains.

The biorefinery design parameters and associated values necessary to estimate emissions and therefore concentrations of air pollutants under the Proposed Action will not be finalized until after publication of this draft Abengoa Biorefinery Project EIS. The description of the biorefinery and its operation discussed in Chapter 2, and the estimates of air pollutant emissions shown in Table 5-2, represent the latest available information (as of August 2009). The air pollutant concentrations shown in Table 5-3, however, represent the design parameters and associated values of an earlier biorefinery design (April 2009).

Table 5-1. Emission sources of the biorefinery and grain-to-ethanol facility.

Equipment/Process	Expected emissions
Onsite biomass handling and milling	PM, PM_{10}, and $PM_{2.5}$
Onsite grain handling and milling	PM, PM_{10}, and $PM_{2.5}$
Enzymatic hydrolysis pretreatment, fermentation, and distillation	PM, PM_{10}, and $PM_{2.5}$, VOCs, HAPs, GHGs
Grain fermentation and distillation	PM, PM_{10}, and $PM_{2.5}$, VOCs, HAPs, GHGs
Lignin-rich stillage storage and loadout	VOCs and HAPs
Dry distiller's grains drying, storage, and loadout	PM, PM_{10}, and $PM_{2.5}$, NO_x, SO_2, CO, VOCs, HAPs, GHGs
Wet distiller's grains storage and loadout	VOCs and HAPs
Ethanol and denaturant loadout	PM, PM_{10}, and $PM_{2.5}$, VOCs, HAPs
Power generation	PM, PM_{10}, and $PM_{2.5}$, NO_x, SO_2, CO, VOCs, HAPs, GHGs
Ash storage and handling	PM, PM_{10}, and $PM_{2.5}$
Cooling towers and air condensers	PM, PM_{10}, and $PM_{2.5}$
Emergency equipment	PM, PM_{10}, and $PM_{2.5}$, NO_x, SO_2, CO, VOCs, HAPs, GHGs
Fugitive emissions	PM, PM_{10}, and $PM_{2.5}$, VOCs, HAPs

Source: ABHK 2009.
CO = carbon monoxide.
GHG = greenhouse gas (such as, carbon dioxide, methane).
HAP = hazardous air pollutant (such as, acetaldehyde and formaldehyde).
NO_x = nitrogen oxides.
PM_{10} = particulate matter with an aerodynamic diameter less than or equal to 10 micrometers.
$PM_{2.5}$ = particulate matter with an aerodynamic diameter less than or equal to 2.5 micrometers.
PM = particulate matter.
SO_2 = sulfur dioxide.
VOC = volatile organic compound (such as, ethanol).

In general, the most recent design (August 2009) calls for a relative increase in the amount of biomass processed in the biorefinery [2,500 versus 1,700 dry short tons (2,300 versus 1,500 dry metric tons) per day], which results in a relative increase in the production of ethanol [18 versus 12 million gallons (68 versus 45 million liters) per year], electricity (92 versus 60 megawatts) and associated *byproducts* and wastes. No *syngas* would be produced by the August 2009 design.

DOE anticipates the final design parameters and associated values would likely result in air pollutant concentrations greater than those shown in Table 5-3; however, they are not likely to increase substantially. Preliminary calculations show that when particulate matter, carbon monoxide, sulfur dioxide, and nitrogen oxide emissions are increased to reflect the most recent biorefinery design, the corresponding increase in pollutant concentrations do not approach, and therefore will not exceed, the *National Ambient Air Quality Standards*.

The results of the *dispersion modeling* for the Proposed Action (using the April 2009 biorefinery design) with the grain-to-ethanol facility are shown in Table 5-3. The operational scenario with 50-percent dried distiller's grains with solubles was chosen for analysis since the facility-wide emissions would be higher (more conservative) than the operational scenario with 100-percent wet distiller's grains with solubles. The former scenario emissions would be higher because of the operation of the dryer to dry the distilled

Table 5-2. Summary of emissions from the biorefinery (Proposed Action) with grain-to-ethanol facility.

Pollutant	50% Dried distiller's grains production				100% Wet distiller's grains production			
	Uncontrolled facility-wide emissions		Controlled facility-wide emissions		Uncontrolled facility-wide emissions		Controlled facility-wide emissions	
	Tons per year[a]	Metric tons per year	Tons per year[a]	Metric tons per year	Tons per year[a]	Metric tons per year	Tons per year[a]	Metric tons per year
Particulate matter	5,965.39	5,411.68	292.68	265.51	5,813.70	5,274.07	278.11	252.30
PM_{10}	4,821.73	4,374.18	267.36	242.54	4,650.29	4,218.65	252.02	228.63
$PM_{2.5}$	3,564.83	3,233.94	254.70	231.06	3,387.30	3,072.89	239.11	216.92
Nitrogen oxides	2,064.90	1,873.24	1,072.99	973.40	2,049.87	1,859.60	1,057.96	959.76
Sulfur dioxide	1,658.42	1,504.49	167.21	151.69	1,658.22	1,504.30	167.01	151.51
Carbon monoxide	1,157.63	1,050.18	1,157.63	1,050.18	1,130.30	1,025.39	1,130.30	1,025.39
Volatile organic compounds	12,178.07	11,047.70	289.19	262.35	11,427.31	10,366.63	275.79	250.19
Single hazardous air pollutant	1,853.96	1,681.88	18.54	16.82	1,853.96	1,681.88	18.54	16.82
Total hazardous air pollutants	2,496.79	2,265.04	44.12	40.02	2,439.94	2,213.46	42.93	38.95

a. Source: Roach 2009c.
PM_{10} = particulate matter with an aerodynamic diameter less than or equal to 10 micrometers.
$PM_{2.5}$ = particulate matter with an aerodynamic diameter less than or equal to 2.5 micrometers.

Table 5-3. Summary of model results for the Proposed Action with grain-to-ethanol facility.

Pollutant	Averaging period	Year of maximum modeled impact[a]	NAAQS[b] (μg/m³)	Background[c] (μg/m³)	Maximum model increment (μg/m³)	Impact (μg/m³) Proposed Action and grain-to-ethanol	Proposed Action only
Carbon monoxide	1-hour	2003	40,000	2,300	800	3,100	3,100
	8-hour	2003	10,000	570	120	690	690
Nitrogen dioxide	Annual	2002	100	8.0	11	19	18
Sulfur dioxide	3-hour	2003	1,300	10	40	50	50
	24-hour	2004	370	8.0	10	18	18
	Annual	2002	78	3.0	1.3	4.3	4.3
PM_{10}	24-hour	2005	150	60	30	90	80
	Annual	2005	Revoked[d]	20	7.5	28	25

a. The modeling analysis was completed using five years of processed meteorological data from 2002 through 2006.
b. Source: 40 CFR Part 50.
c. Source: Lavery 2009.
d. The PM_{10} annual standard was 50 μg/m³ prior to being revoked by EPA.
EPA = U.S. Environmental Protection Agency.
mg/m³ = milligrams per cubic meter.
NAAQS = National Ambient Air Quality Standards.
PM_{10} = particulate matter with an aerodynamic diameter less than or equal to 10 micrometers.
μg/m³ = micrograms per cubic meter.

grains. Emission rates used in the model were based on controlled emissions because the proposed controls would be a requirement under the air permit to be issued by the Kansas Department of Health and Environment, Bureau of Air and Radiation (ABHK 2008, 2009). Additional details of the analytical approach, parameters used, receptor locations, and other information relevant to the air dispersion model are provided in Appendix F of this Biorefinery Project EIS.

The additional emissions from the grain-to-ethanol facility (relative to those of the biorefinery) result in an increase to the modeled *ambient air* concentrations for most of the pollutants and averaging times. The cumulative concentrations of sulfur dioxide and carbon monoxide are equivalent to those of the Proposed Action. The 1-hour carbon monoxide concentrations are the same because the source with the largest contribution to the impact is the emergency generator and the emissions are the same from that source either with or without the grain-to-ethanol facility. The 8-hour carbon monoxide concentrations are the same because the sources with the largest contribution to the impact are the emergency generator and the biomass boilers, and the emissions are the same from those sources either with or without the grain-to-ethanol facility. The sulfur dioxide cumulative concentrations are equivalent because the emissions, either with or without the grain-to-ethanol facility, are almost the same because the additional boilers in the grain-to-ethanol facility would not be large emitters of sulfur dioxide. The resulting cumulative modeled concentrations with the addition of existing background concentrations are well below the National Ambient Air Quality Standards.

The grain-to-ethanol facility would incorporate best management practices and *best available control technologies* to reduce its emissions. These practices and technologies, which were considered in the dispersion modeling, include:

- Use of dust collectors (baghouses) to reduce particulate matter, PM_{10}, and $PM_{2.5}$ emissions in the onsite grain handling and milling systems, and from loadout of dried distiller's grains with solubles.
- Maintenance of negative pressure at grinding systems to increase capture efficiency of particulate matter, PM_{10}, and $PM_{2.5}$ emissions resulting from the grain milling process.
- Installation and operation of high-efficiency wet scrubbers on grain fermentation and distillation operations to control volatile organic compounds and hazardous air pollutants.
- Installation and operation of condensers on grain process vents to control volatile organic compounds.
- Use of natural gas as the fuel for the dryer to reduce emissions from drying wet distiller's grains with solubles.
- Use of a flue-gas recirculation system (similar to a thermal oxidizer system) to reduce overall emissions in the wet distiller's grains dryer.

The biorefinery (Proposed Action) and grain-to-ethanol facility would be a source of greenhouse gases, with carbon dioxide being the most abundant. The biomass boilers would be the main source of carbon dioxide, methane, and nitrous oxide. The natural gas boilers would also be a source of carbon dioxide, methane, and nitrous oxide, but would emit much lower amounts than would the biomass boilers. Carbon dioxide would also be emitted by both the grain and biomass fermentation processes. Table 5-4 shows a summary of the greenhouse gas emission sources for the biorefinery with grain-to-ethanol facility.

Table 5-4. Summary of biorefinery (Proposed Action) with grain-to-ethanol facility greenhouse gas emissions.

	Controlled facility-wide greenhouse gas emissions					
	Carbon dioxide		Methane		Nitrous oxide	
Emission Source	Tons per year[a]	Metric tons per year	Tons per year[a]	Metric tons per year	Tons per year[a]	Metric tons per year
Grain fermentation process vent	301,929	273,905	0	0	0	0
Distiller's grain dryer	41,169	37,348	0.75	0.68	0.08	0.07
Biomass fermentation and distillation process vent	56,617	51,361	0	0	0	0
Biogas flare	717	650	0.001	0.0009	0.0001	0.00009
Biomass boiler #1	782,699	710,053	255	231	33.4	30.3
Biomass boiler #2	782,699	710,053	255	231	33.4	30.3
Natural gas boiler #1	47,350	42,955	0.89	0.81	0.09	0.08
Natural gas boiler #2	47,350	42,955	0.89	0.81	0.09	0.08
Natural gas boiler #3	47,350	42,955	0.89	0.81	0.09	0.08
Natural gas boiler #4	47,350	42,955	0.89	0.81	0.09	0.08
Firewater pump engine	190	172	0.008	0.007	0.002	0.002
Emergency power generator	616	559	0.03	0.03	0.005	0.005
Total	2,156,036	1,955,921	514	466	67	61

a. Source: Roach 2009c.

To evaluate non-carbon dioxide greenhouse gas emissions from the Abengoa biorefinery with grain-to-ethanol facility, the mass estimates of the non-carbon dioxide greenhouse gas emissions were converted into a carbon dioxide equivalent value. Table 5-5 presents the non-carbon dioxide greenhouse gas emissions in terms of carbon dioxide equivalents using two sets of global warming potentials: one drawn from the Technical Summary of the Intergovernmental Panel on Climate Change's Fourth Assessment Report (Solomon et al. 2007) and one drawn from the Panel's Second Assessment Report (IPCC 1995). The total greenhouse gas emissions in carbon dioxide equivalents from the Abengoa biorefinery with grain-to-ethanol facility would be the sum of the total carbon dioxide from Table 5-4, the total methane in carbon dioxide equivalents from Table 5-5, and the total nitrous oxide in carbon dioxide equivalents from Table 5-5.

Based on the emission estimates for the biorefinery (Proposed Action) and the grain-to-ethanol facility, about 2,190,000 tons (2 million metric tons) of greenhouse gases (carbon dioxide equivalent) would be emitted annually (Roach 2009c). However, carbon dioxide from the main fermentation vent scrubber of the grain-to-ethanol facility would be captured and sent offsite for possible use in enhanced oil recovery systems. Carbon dioxide capture would reduce emissions by about 302,000 tons (274,000 metric tons) annually, resulting in an annual release of approximately 1.9 million tons (1.7 million metric tons) per year of carbon dioxide equivalent; this represents a 14-percent increase in greenhouse gas emissions over those of the Proposed Action.

Greenhouse gases emitted by the Abengoa biorefinery (Proposed Action) with grain-to-ethanol facility would mix and be stable in the atmosphere and would not result in any direct impacts to the Hugoton area. The emissions would pose no direct hazard to human health, such as from toxicity or asphyxiation, and any incremental climate change impacts attributable to the relatively small quantities of greenhouse gases the Abengoa biorefinery with grain-to-ethanol facility would emit would be too small to observe, either globally or in the Hugoton area. However, the greenhouse gases the Abengoa biorefinery with grain-to-ethanol facility would emit would add to past and future emissions from all other sources of U.S. and global greenhouse gas emissions, contributing to cumulative impacts on climate change, such as those described in Chapter 4, Section 4.2.1.3.2. At present there is no methodology that would allow DOE to correlate greenhouse gas emissions from the Abengoa biorefinery with grain-to-ethanol facility to any specific climate change impact.

Although the grain-to-ethanol facility would be a source of greenhouse gas emissions, the additional production of ethanol (biofuel) from the grain-to-ethanol facility would be beneficial to the overall greenhouse gas lifecycle because the ethanol would displace the use of fossil fuels. DOE evaluated these benefits based on an analysis using the Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET) Model (Wang et al. 2007a) of the grain-to-ethanol facility. The *GREET Model* for the grain-to-ethanol facility includes farming (direct fuel estimates for powering farming equipment, drying corn, irrigation, and other farming operations), harvesting, transporting the corn to the grain-to-ethanol facility, processing the corn into ethanol, transporting the fuel to stations, and using the fuel in vehicles.

Because the grain-to-ethanol facility would be operating in parallel with the biorefinery under the Proposed Action, the reduction in greenhouse gas emissions resulting from the lifecycle analysis of the grain-to-ethanol facility would be in addition to the greenhouse gas emissions reduction based on the lifecycle analysis of the Proposed Action. As with the biorefinery under both the Proposed Action and Action Alternative presented in Chapter 4, Section 4.2, the GREET Model analysis of the grain-to-ethanol

Table 5-5. Summary of the Abengoa biorefinery (Proposed Action) with grain-to-ethanol facility carbon dioxide equivalents.

	Fourth Assessment Report values[a]				Second Assessment Report values[b]			
	Methane		Nitrous oxide		Methane		Nitrous oxide	
Emission Source	Tons per year	Metric tons per year	Tons per year	Metric tons per year	Tons per year[c]	Metric tons per year	Tons per year[c]	Metric tons per year
Grain fermentation process vent	0	0	0	0	0	0	0	0
Distiller's grain dryer	18.8	17.1	22.5	20.4	15.8	14.3	23.3	21.1
Biomass fermentation and distillation process vent	0	0	0	0	0	0	0	0
Biogas flare	0.02	0.02	0.03	0.03	0.02	0.02	0.03	0.03
Biomass boiler #1	6,363	5,772	9,954	9,030	5,345	4,849	10,355	9,394
Biomass boiler #2	6,363	5,772	9,954	9,030	5,345	4,849	10,355	9,394
Natural gas boiler #1	22.3	20.2	26.6	24.1	18.7	17.0	27.7	25.1
Natural gas boiler #2	22.3	20.2	26.6	24.1	18.7	17.0	27.7	25.1
Natural gas boiler #3	22.3	20.2	26.6	24.1	18.7	17.0	27.7	25.1
Natural gas boiler #4	22.3	20.2	26.6	24.1	18.7	17.0	27.7	25.1
Firewater pump engine	0.19	0.17	0.46	0.42	0.16	0.15	0.48	0.44
Emergency power generator	0.63	0.57	1.51	1.37	0.53	0.48	1.57	1.42
	Tons per year		Metric tons per year		Tons per year		Metric tons per year	
Total carbon dioxide equivalents[d]	2,188,910		1,985,743		2,187,663		1,984,613	

a. The global warming potentials for methane and nitrous oxide are 25 and 298, respectively (Solomon et al. 2007).
b. The global warming potentials for methane and nitrous oxide are 21 and 310, respectively (IPCC 1995).
c. Source: Roach 2009c
d. Total carbon dioxide equivalents are the sum of the total non-carbon dioxide equivalents (methane and nitrous oxide) and the total carbon dioxide from Table 5-4.

facility was compared with the baseline scenario in which passenger vehicles utilized 100-percent conventional and/or reformulated gasoline.

Of the parameters accounted for in the model for corn ethanol production, the two that have the most significant effects on emissions are corn farming and ethanol production (Wang et al. 2007b). In the GREET Model, it was assumed that the ethanol from the grain-to-ethanol facility would be produced from 100-percent corn. Although the feedstock for the grain-to-ethanol facility would be approximately 30-percent corn and 70-percent grain sorghum, the GREET Model does not account for grain sorghum. Relative to grain sorghum, however, corn generally requires greater chemical inputs (fertilizer, pesticides) and irrigation; therefore, modeling 100-percent corn bounds the greenhouse gas emissions.

To be conservative, DOE also assumes in the GREET Model that there would be emissions resulting from land use changes associated with increased corn demand to satisfy feedstock requirements of the grain-to-ethanol facility. However, the land use analysis in Section 5.2.1.2.3 states land use changes are not anticipated. Further, the model accounts for emissions associated with agricultural chemicals (fertilizers and pesticides) used in corn farming and the production of those chemicals. Nitrous oxide emissions from nitrification and denitrification of nitrogen fertilizer in cornfields are a significant source of greenhouse gas emissions for corn ethanol facilities (Wang et al. 2007b).

Consistent with the grain-to-ethanol facility's maximum drying capability, DOE assumes in the GREET Model that 50 percent of the wet distiller's grain would be dried. Unlike the biorefinery under the Proposed Action, the grain-to-ethanol facility would not be exporting power to the grid, thus no emission credit for power export is generated by the GREET Model. The GREET Model representation of the grain-to-ethanol facility includes 100-percent carbon dioxide capture from the fermentation and distillation process. Section F.15 in Appendix F of this Bioenergy Project EIS contains a more complete discussion on the parameters that were used in the GREET Model.

The GREET Model was used to compare three scenarios in greenhouse gas emissions with the baseline scenario—(1) vehicles fueled only by ethanol (E100), (2) vehicles fueled by 85-percent ethanol and 15-percent gasoline (E85), and (3) vehicles fueled by 10-percent ethanol and 90-percent gasoline (E10) . Based on the GREET Model, the grain-to-ethanol facility under the first scenario would result in a 69-percent reduction in greenhouse gas emissions compared with the gasoline baseline scenario (VanPelt 2009). In the second scenario, DOE estimates that a 62-percent reduction in greenhouse gas emissions (VanPelt 2009) could be achieved. In the third scenario, DOE estimates that a 4-percent reduction in greenhouse gas emissions could be achieved relative to the baseline scenario (VanPelt 2009).

These reductions in greenhouse gas emissions are only for the grain-to-ethanol facility with carbon dioxide capture. Therefore, adding the grain-to-ethanol facility to the biorefinery (Proposed Action) would increase the overall benefit to the greenhouse gas lifecycle compared with the gasoline-only scenario. In a study that used the GREET Model to examine the greenhouse gas reduction from the corn ethanol lifecycle compared with the gasoline lifecycle, it was concluded, depending on the type of fuel used to power the ethanol facility (and no carbon dioxide capture), that a 3-percent increase to a 52-percent reduction in greenhouse gas emissions could be achieved (Wang et al. 2007b). Thus, the grain-to-ethanol facility with carbon dioxide capture would achieve a greater reduction in greenhouse gas emissions than similar facilities without carbon dioxide capture.

To summarize, the addition of a grain-to-ethanol facility to the biorefinery (Proposed Action) would result in cumulative impacts to air quality. When added to regional ambient air quality background concentration values, however, the cumulative concentrations remain well below the National Ambient Air Quality Standards. Consequently, the cumulative concentrations would not degrade the ambient air quality to levels that pose a risk to the public. Further, while the overall greenhouse gas emissions would increase by 14 percent of the grain-to-ethanol facility, the benefits to the greenhouse gas lifecycle also would increase through the increased production of biofuel and through carbon dioxide capture.

5.2.2.3 Grain-to-Ethanol Operations Relative to Action Alternative

The emissions from the Action Alternative would be less than the emissions from the Proposed Action because under the Action Alternative, the biorefinery would not produce excess electricity for sale to the regional power grid. Thus, the Action Alternative would only require one small solids boiler rather than two larger boilers thereby reducing emissions. For this reason, the addition of a grain-to-ethanol facility to the biorefinery under the Action Alternative would result in lower emissions and, therefore, lower cumulative concentrations of air pollutants than those described above in Section 5.2.2.2. Although a source of greenhouse gas, the addition of the grain-to-ethanol facility with carbon dioxide capture to the biorefinery under the Action Alternative would remain beneficial to the overall greenhouse gas lifecycle, in that it would result in an increased reduction in greenhouse gas compared with the baseline gasoline scenario.

5.2.3 HYDROLOGY

5.2.3.1 Surface Water

Surface water-related activities associated with the grain-to-ethanol facility would be very similar to those described in Chapter 4, Section 4.3.1.1 for the Proposed Action. Any incremental impacts would be minor because there are limited surface water features in the immediate area of the biorefinery parcel. The most significant features in the vicinity are the numerous *depressions* or *playa* areas where runoff accumulates before it can evaporate or soak into the ground. The following discussion addresses the potential impact areas presented in Section 4.3.1.1. Within each impact area, the grain-to-ethanol facility is first addressed relative to the Proposed Action, then it is addressed relative to the Action Alternative.

5.2.3.1.1 *Planned and Accidental Releases*

Grain-to-Ethanol Construction Relative to the Proposed Action

Potential contaminants present during construction would consist mostly of fuels (diesel and gasoline) and lubricants (oils and grease) for equipment. As with the Proposed Action construction, these materials would be expected to be present only in the equipment in which they were used, but if temporary bulk storage tanks were brought to the biorefinery area to support construction activities, they would be required to be located in secondary containment. The grain-to-ethanol facility would require an estimated 7 months for construction. It is possible that having construction activities take place concurrently with biorefinery operations could increase the potential for an accidental release of a hazardous material. Any increase in potential would be minor and were such a release to happen, possible impacts would be no different than those for the Proposed Action (cumulative impacts would be small). The area of the proposed biorefinery drains to low areas that are internal to the property, and it would be unlikely that any released material could escape the area before response actions were taken. As identified for the

Proposed Action, the Storm Water Pollution Prevention Plan for Construction Activities would be prepared and implemented to address erosion and sediment control measures and other pollution prevention measures that would be taken at the biorefinery area during construction of the grain-to-ethanol facility.

Grain-to-Ethanol Operations Relative to the Proposed Action

During combined operation of the biorefinery and grain-to-ethanol facility, the only planned release would be non-contact cooling water that would be used for irrigation of the adjacent buffer area. The amount of non-contact cooling water generated would increase from a nominal rate of 225 gallons per minute (850 liters) to 460 gallons (1,740 liters) per minute (Roach 2009e) with the addition of the grain-to-ethanol facility. The holding pond constructed under the Proposed Action for collection of non-contact cooling water during winter months when irrigation could not be performed would have be expanded to accommodate a 90-day holding capacity (Roach 2009f) for the increased production rate. This would increase the amount of land disturbed (described later), but the potential impacts from the disposition of the non-contact cooling water would otherwise be the same as for the Proposed Action.

The volumes and types of *hazardous materials* that would be present at the biorefinery would generally increase with incorporation of the grain-to-ethanol facility. However, the measures described in the Proposed Action to provide secondary containment for storage areas and to control drainage from material transfer areas would be expanded as necessary to accommodate the increased inventory. As with the Proposed Action, the entire built-up area would be designed to drain toward low areas within the facility property. In the unlikely event there was a hazardous constituent released or spilled during operations concurrent with a storm event, any contaminated runoff would flow to those low areas where response actions would be initiated. The facility would be designed so that under most storm conditions, no runoff would leave the section of land that would contain the biorefinery and grain-to-ethanol facility (that is, the biorefinery parcel) (Roach 2009g). In the event runoff was great enough to flood the low areas within the biorefinery parcel, overflow would flow to adjacent property to the south or to the buffer area to east. Since these areas are internally drained, there would be no mechanism to move contamination any appreciable distance beyond the Biorefinery Project site boundary. The facility's Spill Prevention Control and Countermeasures Plan would contain applicable response procedures and reporting requirements should a release of a petroleum product or hazardous chemical occur.

Grain-to-Ethanol Construction Relative to the Action Alternative

The potential for accidental releases to occur during construction would be no different than described above for the Proposed Action. With or without the co-generation component, the types of activities and the types and volumes of hazardous materials that would be present at the biorefinery during construction of the grain-to-ethanol facility would be very similar. The types of precautions and planning, as well as any response actions that would be implemented, would be the same.

Grain-to-Ethanol Operations Relative to the Action Alternative

During operations, there would be a change to the volume of non-contact cooling water that would be discharged, otherwise the potential for releases to occur would be no different than described above for the Proposed Action. Under the Action Alternative, the amount of non-contact cooling water generated would increase from a nominal rate of 115 gallons (435 liters) per minute to a rate of 350 gallons (1,320 liters) per minute (Roach 2009e) with the addition of the grain-to-ethanol facility. Again, the holding pond for collection of the non-contact cooling water during winter months would be expanded to accommodate a 90-day holding capacity (Roach 2009f). The potential impacts from the disposition of the non-contact cooling water would otherwise be the same as described above for the Proposed Action with the grain-to-ethanol facility.

The volumes and types of hazardous materials that would be present at the biorefinery would generally be greater under the Proposed Action with incorporation of the grain-to-ethanol facility than under the Action Alternative. However, the physical measures constructed and the planning implemented to reduce the potential for accidental releases would be the same as described for the Proposed Action.

5.2.3.1.2 *Surface Water Runoff Rates, Infiltration Rates, and Drainage Features*

Grain-to-Ethanol Construction Relative to the Proposed Action

Construction of the grain-to-ethanol facility would require additional land disturbance, and the disturbed area would be expected to experience at least temporary changes in the rates of infiltration and runoff. The biomass and the grain-to-ethanol facilities would disturb an estimated 71 acres (0.29 square kilometer) compared with the 66 acres (0.27 square kilometer) required for the biorefinery (Roach 2009h). However, since the grain-to-ethanol facility would be constructed after the biorefinery was in operation, much of the 66 acres originally disturbed would have been restored to pre-disturbance condition, and the new construction would re-disturb much of that area. Under the Proposed Action, the central area where essentially all of the facilities would be located would occupy about 30 acres (0.12 square kilometer) (Roach 2009i). So the new, or relatively new, land disturbance associated with construction of the grain-to-ethanol facility could be as much as about 41 acres (71 acres minus 30 acres) (0.17 square kilometer). Once the grain-to-ethanol facility was constructed, the central area where essentially all of the facilities would be located would be increased from about 30 acres (0.12 square kilometer) to 60 acres (0.24 square kilometer) (Roach 2009i). The amount of built-up area with little or no infiltration and thus heavier runoff would double with the grain-to-ethanol facility. The land area involved is very small in comparison with the Upper Cimarron-Liberal *watershed* area of 1,720 square miles (4,500 square kilometers) (Chapter 3, Section 3.4.1.1). More importantly, even with the increased amount of relatively impervious ground, the resulting increase in the amount of runoff that would be expected would be controlled within the biorefinery area.

The facility's Storm Water Pollution Prevention Plan for Construction Activities would address any best management practices required or deemed necessary to minimize or control erosion during construction. Typical practices considered would be the same ones identified for the Proposed Action (Chapter 4, Section 4.3.1.1.2).

Grain-to-Ethanol Operations Relative to the Proposed Action

As with the Proposed Action, storm water runoff control during operation of the grain-to-ethanol facility would consist of designed and constructed elements within the built-up area to move surface runoff toward natural low areas to the southwest and the east. These runoff control elements would include sloping areas toward roadways where there would be earthen-lined ditches or paved, shallow channels to carry runoff away from the facilities. Culverts would be installed under the roadways as necessary to divert runoff to the desired locations. The culverts, ditches, and swales would be designed to accommodate a 20-year, 20-minute design storm (Roach 2009g). These features would direct runoff to the same two natural low areas described for the Proposed Action. One area is located in the central area of the western half section of the biorefinery parcel, and the other is at the eastern boundary of the parcel, adjacent to Road 11, which separates the biorefinery parcel from the buffer area. The low area to the west would catch all runoff from within the railroad spur loop on the western side of the biorefinery area (Roach 2009g). Since there would be relatively little construction in this portion of the parcel, there would be little change in the amount of runoff naturally reaching this low area. The low area to the east would catch runoff from the largest portion of the built-up area of the biorefinery parcel; that area lying east of the railroad spur. This area would collect runoff from about 180 acres (0.73 square kilometer), including much of the 60 acres (0.24 square kilometer) of built-up area. As a result, unless the surrounding soil were already saturated or frozen, this low area would be expected to receive larger quantities of runoff drainage than under natural conditions and larger quantities than under the Proposed Action.

For precipitation or snow-melt runoff to overflow the east low area, the level of accumulated water would have to overflow Road 11, which is several feet higher than the field area along this side of the biorefinery parcel (Roach 2009g). Were this to happen, water would overflow to the east, to the low area in the buffer area between the biorefinery and the city of Hugoton. This is the area where runoff currently accumulates. This property is currently used for agriculture, and minor changes in the amount of run-on would not result in cumulative impacts. As described for the Proposed Action, the changes in runoff amounts and in accumulation areas would be associated with corresponding changes in infiltration rates and locations, but they would be minor and insignificant in comparison with the infiltration that occurs in the much larger watershed. Even with the grain-to-ethanol facility, there would be no effects on surface water drainage or on runoff and infiltration rates on the land areas outside the two sections of property described above.

Grain-to-Ethanol Construction Relative to the Action Alternative

Potential changes to runoff and infiltration rates during construction would be basically the same as described above for the Proposed Action. Without the electrical co-generation component, the amount of land disturbed would decease by about 5 acres (0.02 square kilometer) (Roach 2009i). That is, the total amount of land that would be disturbed with the biorefinery and the grain-to-ethanol facility is estimated to be 66 acres (0.27 square kilometer), compared with 61 acres (0.25 square kilometer) for just the biorefinery. The other acreage values and evaluations described above would be the same.

Grain-to-Ethanol Operations Relative to the Action Alternative

Runoff would be managed as described above for the Proposed Action. The grain-to-ethanol facility would increase the amount of built-up area from about 30 acres (0.12 square kilometer) to 60 acres (0.24 square kilometer), and the natural, low areas to which runoff would be directed would be expected to receive larger quantities of runoff drainage than under natural conditions and larger quantities than under the Action Alternative. As described above for the Proposed Action, even with the grain-to-ethanol facility, there would be no effects on surface water drainage or on runoff and infiltration rates on the land areas outside of the Biorefinery Project site.

5.2.3.2 Groundwater

The addition of a grain-to-ethanol biorefinery would increase the potential incremental effects on the *groundwater* resource compared with either the Proposed Action or Action Alternative alone. Potential impacts to the groundwater resource related to the Proposed Action and Action Alternative were described in Chapter 4, Sections 4.3.1.2 and 4.3.2.2. The following analysis addresses the same potential impact areas as addressed for the Proposed Action and Action Alternative, but with the differences that could be attributed to the addition of a grain-to-ethanol facility.

5.2.3.2.1 *Groundwater Quantity*

Grain-to-Ethanol Facility Construction Relative to the Proposed Action

Construction of a grain-to-ethanol facility would occur during biorefinery operations under the Proposed Action. Therefore, impacts resulting from consumptive water use demand during construction of the grain-to-ethanol facility would be in addition to the consumptive water use demand identified from standard operation of the biorefinery under either the Proposed Action or the Action Alternative.

The additional demand on the groundwater resource for construction of the grain-to-ethanol facility includes the demand on the City of Hugoton's potable water supply by temporary construction workers, and consumptive water use for dust suppression and soil compaction during construction of the grain-to-ethanol facility. The demand on the City of Hugoton's potable water supply is analyzed relative to Utilities and Water in Section 5.2.4.1.1.

It is estimated that 34 gallons (130 liters) per minute would be required from the Hugoton water supply for the construction workers while the grain-to-ethanol facility is being added to the operating biorefinery, which includes 4 gallons (15 liters) per minute for potable supply for the construction workers at the biorefinery during construction. These 34 gallons per minute would be in addition to the ongoing 30-gallon (110-liter)-per-minute demand on Hugoton's water supply for full-time biorefinery operations workers and families residing in Hugoton.

During the construction of the grain-to-ethanol facility, there would be water demand for dust suppression and soil compaction. Since the biorefinery under the Proposed Action would be in operation during this construction, the water source for construction use would be from supply wells used for the operating biorefinery. Water demand estimates for constructing the grain-to-ethanol facility at a later time than the Proposed Action are not available, as construction water demand estimates provided for the Proposed Action and the Proposed Action plus the grain-to-ethanol facility were developed under the assumption that construction of each scenario would occur in a single phase, from start to completion (Roach 2009j). The difference in water use between the Proposed Action [63,000 gallons (238,000 liters) per day], and the Proposed Action plus the grain-to-ethanol facility [72,000 gallons (273,000 liters) per day], is approximately 9,000 gallons (34,000 liters) per day. Construction, including the grain-to-ethanol facility, would require 106 weeks, 30 weeks more than the 76-week construction phase estimated for the Proposed Action (Roach 2009e). The estimated construction water demand for soil compaction and dust suppression under the Proposed Action was a total of approximately 100 acre-feet (0.12 million cubic meters), and the estimated total including the grain-to-ethanol facility would be about 160 acre-feet (0.2 million cubic meters). To supply the additional 60 acre-feet (0.7 million cubic meters) over the additional 30 weeks of construction, a continuous demand of about 66 gallons (250 liters) per minute would be required.

The additional water demand for construction of the grain-to-ethanol facility would be approximately 100 gallons (380 liters) per minute, which includes the water demand of 34 gallons (130 liters) per minute for potable supply to temporary construction workers and 66 gallons (250 liters) per minute for construction water demand for the additional 30 weeks of construction. There is some uncertainty regarding the estimated water demand for construction of the grain-to-ethanol facility if not constructed in single phase with the Proposed Action; however, because the construction water demand would be short term and much less demand than that required for operation of the biorefinery with the grain-to-ethanol facility, conclusions about cumulative impact to groundwater from operations also apply to potential cumulative impacts during construction.

Construction of the grain-to-ethanol facility would increase water demand on the groundwater resource. The increased demand would be cumulative with the demand of the operating biorefinery. The increased demand would be much less than the water demand for biorefinery operations with the grain-to-ethanol facility, and the construction water demand would be of short duration. Therefore, DOE has concluded there would be no adverse cumulative impacts to the groundwater resource resulting from construction of the grain-to-ethanol facility.

Grain-to-Ethanol Facility Operations Relative to the Proposed Action

Potential impact to the groundwater resource for the grain-to-ethanol facility operations would be associated with the same types of activities as those analyzed for the biorefinery under the Proposed Action. There would be a relative increase in the consumptive water demand with the addition of the grain-to-ethanol facility that would result in increased demand on the City of Hugoton water supply because of the greater number of full-time workers living in Hugoton and increased process water demand for facility operations.

The water demand for the increase in the number of full-time workers from 43 under the Proposed Action to 117 workers under the grain-to-ethanol facility is quantified in Section 5.2.4.1.1. The additional demand would be 52 gallons (200 liters) per minute, which includes approximately 4 gallons (15 liters) per minute for potable supply to the biorefinery. This demand would be in addition to the 30 gallons (110 liters) per minute for full-time workers under the Proposed Action, that is, without the grain-to-ethanol facility. The total water demand for potable supply from Hugoton's water system for the Proposed Action with the grain-to-ethanol facility is estimated to be 82 gallons (310 liters) per minute.

The average water demand for the biorefinery and the grain-to-ethanol facility would be 2,330 gallons (8,820 liters) per minute, or about 3,600 acre-feet (4.4 million cubic meters) per year (Roach 2009e). There would be an increase in non-contact wastewater discharge to 460 gallons (1,740 liters) per minute, or about 710 acre-feet per year (0.88 million cubic meters) (Roach 2009e). As conducted in the analysis for the Proposed Action, the full operational demand of about 3,600 acre-feet per year would be considered *consumptive use* in the cumulative impacts analysis (assumes 100 percent of non-contact wastewater is consumptive use).

Table 5-6 summarizes the demand on the High Plains aquifer resulting from the operation of the biorefinery under the Proposed Action and the grain-to-ethanol facility.

Table 5-6. Water demand for operation of the biorefinery (Proposed Action) with the grain-to-ethanol facility.

Consumptive demand	Rate [gallons (liters) per minute]	Volume [acre-feet (million cubic meters) per year]
Biorefinery	2,330 (8,820)	3,600 (4.4)
City of Hugoton	82 (310)	130 (0.16)
Total	2,400 (9,090)	3,730 (4.6)

Note: Totals may differ from sums due to rounding.

Abengoa Bioenergy has optioned existing irrigation water rights for purchase to be converted to industrial use to satisfy the water demand of the proposed biorefinery and the grain-to-ethanol facility. Table 5-7 presents a summary of the optioned water rights. Water rights may have multiple file numbers reflecting an overlapped allocated rate and quantity from a single supply well.

Table 5-7. Water rights Abengoa Bioenergy has optioned.

Water right file numbers[a]	Approved rate [gallons (liters) per minute][a]	Approved quantity [acre-feet (million cubic meters) per year[a]	Approved irrigated[b] [acres (square kilometers)]
12,654; 42612; 42860	2,000 (7,600)	1,216 (1.5)	481(1.95)
41,826	2,500 (9,500)	1,038 (1.3)	550 (2.24)
41,769	1,100 (4,200)	248 (0.3)	143 (0.6)
10,889; 24,931	1,755 (6,600)	1,090 (1.35)	320 (1.3)
26,282	2,000 (7,600)	700 (0.86)	451 (1.8)
728; 11,383	3,195 (12,000)	888 (1.1)	434 (1.77)
10,520	3,000 (11,400)	1,060 (1.3)	555 (2.26)
22,908; 41,202; 42,191	1,900 (7,200)	1,000 (1.2)	500 (2.0)
Total	17,450 (66,000)	7,240 (8.9)	3,434 (13.9)

a. Source: Roach 2009j.
b. Source: KGS 2009.

Based on the description in Chapter 4, Section 4.3.1.2.1 for converting the optioned water rights from irrigation to industrial use in accordance with Kansas regulations, the approved quantity under the optioned water rights would be reduced from 7,240 acre-feet (8.9 million cubic meters) per year for irrigation to approximately 4,220 acre-feet (5.2 million cubic meters) per year for industrial use, an approximate 40-percent reduction. Based on the most recent full year of water use data, the total volume of water used for irrigation from the optioned water rights was approximately 4,240 acre-feet (5.2 million cubic meters) in 2007 (KGS 2009).

The annual water demand for the Proposed Action with the grain-to-ethanol facility would be approximately 3,730 acre-feet (4.6 million cubic meters) per year, which is an approximate 50-percent reduction from the quantity that could be used for irrigation from the optioned water rights [7,240 acre-feet (8.9 million cubic meters)],and an approximate 12-percent reduction from the quantity actually used for irrigation in 2007 from these water rights [4,240 acre-feet (5.2 million cubic meters)]. The annual water demand for the Proposed Action with the grain-to-ethanol facility [3,730 acre-feet (4.6 million cubic meters)] is about 1,560 acre-feet (1.9 million cubic meters) more than the water demand for the Proposed Action alone [2,170 acre-feet (2.7 million cubic meters)]. Table 5-8 provides a comparison of quantities of water removed from use through implementation of the various alternatives and the addition of the grain-to-ethanol facility.

The total water demand for the Proposed Action with the grain-to-ethanol facility is greater than that for the Proposed Action, but both would provide for beneficial impact to the groundwater resource compared with continued operation of the optioned water rights for irrigation use. The savings in water that could be used is realized by conversion of the water rights from irrigation to industrial use, which is generally about a 40-percent reduction. Additional savings is realized by the amount that might be used for biorefinery operations being less than the converted, approved quantity. For the Proposed Action, the resulting approved quantity, 4,220 acre-feet (5.2 million cubic meters) is less than the quantity actually used for irrigation from the optioned water rights in 2007 [4,240 acre-feet (5.2 million cubic meters)]. DOE has concluded there would be no adverse cumulative effects on the quantity aspect of the groundwater resource with the addition of the grain-to-ethanol facility; there would be a net beneficial impact.

Table 5-8. Comparison of groundwater use savings.

	Action Alternative [acre-feet (million cubic meters) per year]	Proposed Action [acre-feet (million cubic meters) per year]	Either action with grain-to-ethanol [acre-feet (million cubic meters) per year]
Optioned water rights[a]	2,200 (2.7)	7,240 (8.9)	7,240 (8.9)
Water used for irrigation in 2007[b]	1,500 (1.9)	4,240 (5.2)	4,240 (5.2)
Water demand, biorefinery[c]	850 (1.0)	2,170 (2.7)	3,730 (4.6)
Quantity removed from use[d]	650 (0.8)	2,070 (2.5)	510 (0.6)
Maximum quantity removed from use[e]	1,350 (1.7)	5,070 (6.2)	3,510 (4.3)

a. Optioned water right quantity prior to conversion from irrigation to industrial use that could be used for irrigation.
b. Quantity reported as used for irrigation from optioned water rights in 2007 (KGS 2009).
c. Estimated water demand for biorefinery operations and potable supply to full-time workers.
d. Potential quantity removed from use assuming non-optioned water rights continued to be used for irrigation. Value obtained by subtracting estimated demand from volume used for irrigation in 2007.
e. Maximum quantity potentially removed from use. Value obtained by subtracting estimated demand from the approved quantity from optioned water rights for irrigation prior to conversion (the quantity that could be used for irrigation).

DOE also considered the potential increase in interference with nearby water users by operation of the biorefinery supply wells with the addition of the grain-to-ethanol facility. When converted to industrial use, the optioned water rights would provide for eight supply wells equipped to produce 850 gallons (3,220 liters) per minute each and operated on a rotational basis (Roach 2009j). The number of wells for the Proposed Action with the grain-to-ethanol facility would be the same as that for the Proposed Action. The approved, combined pumping rate for the wells for the Proposed Action and the Proposed Action with the grain-to-ethanol facility, prior to conversion from irrigation to industrial use, would be 17,450 gallons (66,000 liters) per minute. The average biorefinery operations rate with the addition of the grain-to-ethanol facility would be 2,330 (8,820 liters) gallons per minute (Roach 2009e). Consistent with the analysis for the Proposed Action, changing the use of the supply wells from irrigation to industrial use would result in a reduction in approved pumping rates, less pumping at the approved rates, and spreading the pumping at lower rates over the area of the wells to be operated. DOE has concluded there would be no adverse cumulative effects with the increase in the number of supply wells with the addition of the grain-to-ethanol facility.

DOE evaluated the potential for impacts to groundwater from changes in water use practices within the region of influence resulting from the addition of the grain-to-ethanol facility. Addition of the grain-to-ethanol facility to the Proposed Action would create a new outlet for grain from farming operations within the region of influence, which could cause changes in cropping practices. Changes in cropping practices could result in changes to irrigation practices, creating increased demand and related effects on groundwater. The potential effects to groundwater would relate to irrigation of primarily corn and grain sorghum. DOE concluded in Section 5.2.1, however, that there would be no noticeable change in land use to meet the increase in corn production within the region of influence as a result of adding the grain-to-ethanol facility to the Proposed Action. DOE also concluded there could be an increase in demand and production of grain sorghum within the region of influence, but this would not be anticipated to result in significant land use conversion, which would be expected to limit irrigation of new ground for grain sorghum production. Chapter 4, Section 4.3.1.2.1 describes how the development of irrigation within the region of influence in Kansas would be limited by groundwater management regulation, and while not as limited in the region of influence outside of Kansas, irrigation development would be limited in general by other economic factors and farming practices discussed in Sections 4.1 and 5.2.1. On balance, DOE concludes that the potential exists for changes in cropping practices and associated increases in water use for irrigation within the region of influence as a result of adding the grain-to-ethanol facility to the Proposed Action; however, the increase would be limited and would not create adverse cumulative effects on groundwater.

DOE has concluded there would be no adverse cumulative impacts in terms of groundwater quantity from the addition of the grain-to-ethanol facility. The addition of the grain-to-ethanol facility to the Proposed Action has the potential for cumulative decreases in effects upon the groundwater resource through a beneficial decrease in groundwater use.

Grain-to-Ethanol Construction Relative to the Action Alternative

A comparison of potential effects on groundwater quantity between the Proposed Action and Action Alternative is discussed in Chapter 4, Section 4.3.2.2.1. The comparison demonstrates that water demand during biorefinery construction under the Action Alternative is about 80 percent of the water demand for biorefinery construction under the Proposed Action. The difference relates only to the demand on the City of Hugoton’s water system for potable supply to temporary construction workers, as water demand for dust suppression and soil compaction was the same for the Action Alternative and the Proposed Action.

Construction of the grain-to-ethanol facility under the Action Alternative suggests the same relative increase in water demand on potable supply for construction workers residing in Hugoton in comparison with the Proposed Action. This increase of 34 gallons (130 liters) per minute, which includes 4 gallons (15 liters) per minute for potable supply for temporary workers, is the same because the number of workers required for construction of the grain-to-ethanol facility would be the same. These 34 gallons per minute would be in addition to the existing water demand of 24 gallons (91 liters) per minute for full-time workers and families residing in Hugoton, and to their potable water supply while working at the biorefinery under the Action Alternative.

The water demand for dust suppression and soil compaction for the Action Alternative and Proposed Action would be the same (Roach 2009j). Therefore, there would be 66 gallons (250 liters) per minute construction water demand for the additional 30-week construction period for the grain-to-ethanol facility. There is some uncertainty regarding the estimated water demand for construction of the grain-to-ethanol facility if not constructed in a single phase with the Proposed Action; however, because the construction water demand would be short term and much less demand than that required for operation of the biorefinery with the grain-to-ethanol facility, the conclusions about cumulative impacts to groundwater from operations also apply to potential cumulative impacts during construction.

Construction of the grain-to-ethanol facility would increase water demand on groundwater. The increased demand would be cumulative with the ongoing demand of the operating biorefinery under the Action Alternative. The increased demand would be much less than that for biorefinery operations with the grain-to-ethanol facility, and the construction water demand would be of short duration. Therefore, DOE concludes there would be no adverse cumulative impacts to groundwater from construction of the grain-to-ethanol facility.

Grain-to-Ethanol Operations Relative to the Action Alternative

Effects on groundwater from operation of the biorefinery under the Proposed Action with the addition of the grain-to-ethanol facility are discussed above. The total water demand for the end-result operating biorefinery with grain-to-ethanol operations is the same under the Action Alternative and Proposed Action. Cumulative impacts would relate to the amount of the increase in total water demand realized from adding the grain-to-ethanol facility to the biorefinery under the Action Alternative or the Proposed Action. Other potential impact areas, including the potential interference to nearby water users and potential impact to groundwater from changes in cropping patterns and irrigation use within the region of influence would be as discussed for the Proposed Action with the grain-to-ethanol facility; that is, no adverse cumulative impacts.

Tables 5-6 and 5-7 describe the operational water demand for the biorefinery with the grain-to-ethanol facility and the optioned water rights, respectively. The information in these tables remains the same under the Action Alternative. The total water demand for the biorefinery under the Action Alternative from Table 4-13 in Section 4.3.2.2.1 (Chapter 4 of this EIS) is approximately 850 acre-feet (1.0 million cubic meters) per year, which includes potable supply for full-time workers. The total water demand for the biorefinery with the grain-to-ethanol facility, from Table 5-6, would be 3,730 acre-feet (4.6 million cubic meters) per year, an increase of about 2,900 acre-feet (3.6 million cubic meters) per year from adding the grain-to-ethanol facility to the biorefinery under the Action Alternative.

The total water demand under the Action Alternative with the grain-to-ethanol facility is greater than the water demand for the Action Alternative. The effects on the groundwater resource considering only the total water demand would suggest increased cumulative effects for addition of the grain-to-ethanol facility. However, also considering the total quantity of water approved for irrigation use that could be used, addition of the grain to ethanol facility would result in more of a beneficial effect on the groundwater resource than the Action Alternative. Considering the savings in groundwater use based on the quantity that could be used, or on the quantity actually used for irrigation in 2007, the net effect is a beneficial impact to the groundwater resource for the Action Alternative and the Action Alternative with the addition of the grain-to-ethanol facility. Table 5-8 provides a comparison of the quantity of water that would be removed from use for the biorefinery under the Action Alternative and the biorefinery with the grain-to-ethanol facility. DOE concludes there would be no cumulative adverse impacts to groundwater by the addition of the grain-to-ethanol facility to the Action Alternative.

5.2.3.2.2 *Groundwater Quality*

Grain-to-Ethanol Construction Relative to the Proposed Action

Chapter 4, Section 4.3.1.2.2 identifies the potential effects on the quality of groundwater within the region of influence to be primarily related to *point-source* pollution, which is localized releases of some form of contaminants. Section 5.2.3.1.1 discusses the potential for impacts from releases of potential contaminants during construction and operation of the grain-to-ethanol facility. Any spills of hazardous materials would be handled in accordance with the Spill Prevention, Control, and Countermeasures Plan, minimizing or eliminating potential impacts to groundwater quality from construction of the biorefinery. Section 5.2.3.1.1 concludes that although the extended construction duration for the grain-to-ethanol facility could result in the increased potential for a construction-related release, any such increase would be minor and possible impacts would be no different than those for the Proposed Action.

Grain-to-Ethanol Operations Relative to the Proposed Action

Incorporating the grain-to-ethanol facility would likely increase the amount and types of hazardous materials that would be present at the biorefinery in comparison with just the Proposed Action. However, the measures described in the Proposed Action to provide secondary containment for storage areas and to control drainage from material transfer areas would be expanded as necessary to accommodate the increased inventory. The potential for a release of contaminants that would create adverse effects on groundwater would be very low and essentially the same as that for the Proposed Action.

Grain-to-Ethanol Construction Relative to the Action Alternative

The considerations for the grain-to-ethanol construction relative to the Action Alternative are the same as discussed above for the Proposed Action. The extended construction duration for the grain-to-ethanol facility could increase the potential for a construction-related release, but the increase in potential would be minor and possible impacts would be no different under the Action Alternative.

Grain-to-Ethanol Operations Relative to the Action Alternative

The considerations for the grain-to-ethanol operations relative to the Action Alternative are the same as discussed above for the Proposed Action. The potential for a release of contaminants that would create adverse effects on the groundwater resource would be very low and essentially be the same under the Action Alternative.

5.2.4 UTILITIES, ENERGY, AND MATERIALS

This section discusses the potential cumulative impacts to utilities, energy, and construction materials from construction and operation of a grain-to-ethanol facility with the biorefinery under the Proposed Action and the Action Alternative. Demand for, or loadings on most utilities, energy, and construction materials, would increase as a result of the addition of the grain-to-ethanol facility. The evaluation approach and assumptions and the impact areas considered are the same as those described in Chapter 4, Section 4.5.1 for the Proposed Action. Within each impact area, the grain-to-ethanol facility is first addressed relative to the Proposed Action, then it is addressed relative to the Action Alternative. As for the Proposed Action, impacts to water, sewer, and sanitation services addressed in this section are those associated with the increased population that are assumed to live in Hugoton during construction and operation of the grain-to-ethanol facility. Process water, sewer, and *solid waste* are not considered utility issues and are addressed in other resource areas. Potable water use at the biorefinery would be obtained from the City of Hugoton water utility and is, therefore, addressed in this section. The analysis in this section primarily compares needs (demand) with available capacity.

5.2.4.1 Utilities

The grain-to-ethanol facility would require an estimated peak workforce of 148 during construction and an average workforce of 74 during operations (Roach 2009k). Using the same basis and analytical approach as described for the Proposed Action, the maximum population increase during construction is estimated to be 286 people, and the population increase during operations is estimated to be 241. Both construction and operation of the grain-to-ethanol facility would occur during operation of the biorefinery. The population increase effects of the grain-to-ethanol facility would be relative to an increased population of 140 people during operations under the Proposed Action, and to an increased population of about 110 people during operations under the Action Alternative. The following summaries of impacts to utilities are based on these values.

5.2.4.1.1 *Water*

Grain-to-Ethanol Construction Relative to the Proposed Action

It is estimated that water demand by each of the additional construction-related residents would be about 150 gallons (570 liters) per day. This is the same use rate as for the Proposed Action and is a lower rate than for the average long-term resident. For the 286 additional people this equates to about 42,900 gallons (162,000 liters) per day, or about 30 gallons (110 liters) per minute. Chapter 4, Section 4.5.1.1.1 evaluates an estimated 30 gallons per minute as the quantity that would be associated with the increased population during operations under the Proposed Action. Thus, during the time it would take to construct the grain-to-ethanol facility, water demand associated with the biorefinery would double from about 30 gallons per minute to a combined 60 gallons (230 liters) per minute. If it is assumed that the construction workforce used potable water from within the biorefinery at a rate of 50 gallons (190 liters) per person per workday, this would equate to an average additional water demand of about 4 gallons (15 liters) per minute. These water demands [totaling about 64 gallons (240 liters) per minute] are well within the City of Hugoton's current excess capacity of 190 gallons (720 liters) per minute. Although water demand would more than double when compared with the Proposed Action, the Hugoton water system has sufficient excess capacity such that there would be no adverse cumulative impacts from increased water demand during construction of the grain-to-ethanol facility.

Grain-to-Ethanol Operations Relative to the Proposed Action

During operations, it is estimated that per capita water demand for the additional population of 241 would be no different than that for the current Hugoton population, which is about 302 gallons (1,140 liters) per day per person. This water demand, along with the estimated 50 gallons (190 liters) per workday for the workforce of 74 persons associated with the grain-to-ethanol facility, equates to about 75,400 gallons (285,000 liters) per day, or an average of 52 gallons (200 liters) per minute. This water demand rate would be in addition to the 30 gallons (110 liters) per minute associated with the Project population without the grain-to-ethanol facility. The resulting demand of 82 gallons (310 liters) per minute would be within the City of Hugoton's current excess capacity of 190 gallons (720 liters) per minute, and thus the increased rate would not result in an adverse cumulative impact to the Hugoton water system.

Grain-to-Ethanol Construction Relative to the Action Alternative

During construction of the grain-to-ethanol facility, the additional water demand of about 34 gallons (130 liters) per minute (as derived above) would be relative to the 24 gallons (91 liters) per minute estimated in Chapter 4, Section 4.5.2.1 for operation of the biorefinery under the Action Alternative. The combined 58 gallons (220 liters) per minute would be within Hugoton's current excess capacity of 190 gallons (720 liters) per minute, and thus the increased rate would not result in an adverse cumulative impact to the Hugoton water system.

Grain-to-Ethanol Operations Relative to the Action Alternative

During operation of the grain-to-ethanol facility, the additional water demand of about 52 gallons (200 liters) per minute (as derived above) would be relative to the 24 gallons (91 liters) per minute estimated in Chapter 4, Section 4.5.2.1 for operation of the biorefinery under the Action Alternative. The combined 76 gallons (290 liters) per minute would be within Hugoton's current excess capacity of 190 (720 liters) gallons per minute, and thus the increased rate would not result in an adverse cumulative impact to the Hugoton water system.

5.2.4.1.2 *Sewer*

Grain-to-Ethanol Construction Relative to the Proposed Action

Estimates of sewage production are based on the population increases that would result from construction of the grain-to-ethanol facility. During construction, the population could increase by as many as 286 people, and for the Proposed Action, there would already be an increased population of 140 people due to operation of the biorefinery. The combined population increase would thus be 426 people. This total project-related population along with the existing Hugoton population of 3,400 would have a combined sewage production below the design capacity of the sewage treatment lagoons, which is for a population of 4,000 people. Thus, there would be no adverse cumulative impact to the sewage treatment system.

Grain-to-Ethanol Operations Relative to the Proposed Action

During operation of the grain-to-ethanol facility, the population would increase by an estimated 241 people. With the population increase of 140 people already attributed to operations under the Proposed Action, the total population would be 381 people. This is less than during construction of the grain-to-ethanol facility, and the Hugoton population would remain below the 4,000-resident design capacity of the sewage treatment lagoons. Again, there would be no adverse cumulative impacts.

Grain-to-Ethanol Construction Relative to the Action Alternative

During construction of the grain-to-ethanol facility, the added population of 286 people would be in addition to the added population of 110 people associated with biorefinery operations under the Action Alternative. The combined population would be 396 people, and when added to the Hugoton population of 3,400 people, this would be within the 4,000-resident design capacity of the sewage treatment lagoons. Again, there would be no cumulative adverse impacts to the sewage treatment system.

Grain-to-Ethanol Operations Relative to the Action Alternative

The added population of 241 people attributed to operation of the grain-to-ethanol facility would be in addition to the population increase of 110 people for operation of the biorefinery. The total added population of 352 people would maintain the Hugoton population (starting at 3,400), below the 4,000-resident design capacity of the sewage treatment lagoons. There would be no adverse cumulative impacts to the sewage treatment system.

5.2.4.1.3 *Sanitation Services*

In 2008, an average of 13.3 tons (12.1 metric tons) of solid waste per day was disposed of in the Stevens County landfill. (This excludes a larger volume of one-time waste as described in Chapter 3, Section 3.6.1.3.). The population in Stevens County in 2005 was about 5,300. The evaluations in this section are based on the assumption that the amount of solid waste going to the landfill is directly proportional to the number of people in the county. As indicated in Section 3.6.1.3, the estimated remaining life of the landfill is 119 years, which was calculated in 2008 using an average disposal rate of 12.6 tons (11.4 metric tons) per day (KDHE 2008). Since the life of a landfill with a set volume capacity decreases linearly with increases in the disposal rate, the life of the landfill would be reduced to 113 years if the disposal rate of 13.3 tons per day had been used.

Grain-to-Ethanol Construction Relative to the Proposed Action

During construction of the grain-to-ethanol facility, the population could increase by as many as 286 people in addition to the increased population of 140 people due to operation of the biorefinery under the

Proposed Action. Thus, the population of Stevens County would increase by 2.6 percent as a result of the Proposed Action, and during construction of the grain-to-ethanol facility, the total population increase would be about 8 percent. The average waste disposal rate at the landfill would thereby increase from 13.3 tons (12.1 metric tons) per day to 13.6 tons (12.3 metric tons) per day for operations under the Proposed Action, and would increase to 14.4 tons (13.1 metric tons) per day during construction of the grain-to-ethanol facility. At the Proposed Action disposal rate of 13.6 tons per day, the 2008 life of the landfill would decrease from 113 to 111 years and at the disposal rate of 14.4 tons per day, the life of the landfill would decrease further to 104 years. These disposal rates would be well below the landfill's 20-ton (18.1-metric-ton) per day operating limit, and the life of the landfill would still be long, even assuming the disposal rate increases were long term and no new land was available for landfill expansion or relocation. The increased waste production rate would not result in an adverse cumulative impact to the Steven's County landfill.

Grain-to-Ethanol Operations Relative to the Proposed Action

During combined operation of the biorefinery and grain-to-ethanol facility, the Project-related population would increase from 140 (without the grain-to-ethanol facility) to 381 people. Accordingly, the increase in the Stevens County population would change from 2.6 percent to 7.2 percent, and the average waste disposal rate at the landfill would increase from 13.6 tons (12.3 metric tons) per day for operations under the Proposed Action to 14.3 tons (13 metric tons) per day during operation of the grain-to-ethanol facility. These disposal rates would be well below the landfill's 20-ton (18-metric-ton) per day operating limit, and would have only minor effects on the landfill's estimated life. The increased waste production rate would not result in an adverse cumulative impact to the Steven's County landfill.

Grain-to-Ethanol Construction Relative to the Action Alternative

During construction of the grain-to-ethanol facility, the population would increase by 286 people in addition to the increased population of 110 people for operation of the biorefinery under the Action Alternative. The population of Stevens County would have increased by 2.1 percent as a result of the Action Alternative, and during construction of the grain-to-ethanol facility, the total Project increase would be about 7.5 percent. The average waste disposal rate at the landfill would increase from 13.3 tons (12.1 metric tons) per day to 13.6 tons (12.3 metric tons) per day for operations under the Action Alternative, and would increase to 14.3 tons (13 metric tons) per day during the construction of the grain-to-ethanol facility. These disposal rates would be well below the landfill's 20-tons (18-metric-ton) per day operating limit and would have only minor effects on the landfill's estimated life. The increased waste production rate would not result in an adverse cumulative impact to the Steven's County landfill.

Grain-to-Ethanol Operations Relative to the Action Alternative

Under the Action Alternative, operation of the biorefinery with the grain-to-ethanol facility would be associated with a Project-related population that increased from 110 (without the grain-to-ethanol facility) to 352 people. Accordingly, the increase in the Stevens County population would change from 2.1 percent to 6.6 percent, and the average waste disposal rate at the landfill would increase from 13.6 tons (12.3 metric tons) per day for operations under the Proposed Action to 14.2 tons (12.9 metric tons) per day during operation of the grain-to-ethanol facility. These disposal rates would be well below the landfill's 20-ton (18-metric-ton) per day operating limit and would have only minor effects on the landfill's estimated life. The increased waste production rate would not result in an adverse cumulative impact to the Steven's County landfill.

5.2.4.2 Energy

5.2.4.2.1 *Electrical Power*

No estimates were generated for electrical demand associated with construction of the grain-to-ethanol facility. It is assumed that electrical demand during this work would be limited to that needed to support intermittent power tools and lighting, and that the electrical demand would be minor compared with the steady loads associated with facility operations. As a result, the discussions in this section deal only with the impacts of operations under the Proposed Action and the Action Alternative.

Grain-to-Ethanol Operations Relative to the Proposed Action

Operation of the grain-to-ethanol facility would involve peak and average electrical demands of 15 and 10 megawatts, respectively (Roach 2009l). Linked with the Proposed Action (biorefinery), this would reduce the amount of electrical power the Project would provide to the regional transmission grid. As described in Chapter 4, Section 4.5.1.2.1, the electrical co-generation component of the Proposed Action would provide an average of 70 megawatts of electrical power to the regional grid. At times of peak internal demand, this would be reduced to 60 megawatts. With the addition of the grain-to-ethanol facility, these values would be reduced to an average of 60 megawatts going to the grid and at times when there were peak electrical demands, the amount supplied to the grid would be further reduced to 50 megawatts (Roach 2009e). This reduction of 10 megawatts in the amount of power normally supplied to the grid can be compared with the City of Hugoton's capability to produce approximately 21 megawatts when sufficient power cannot be obtained from the grid and with the current combined capability of Sunflower Electric Power Corporation and Mid-Kansas Electric Company to produce almost 1,300 megawatts. Finally, the change can be compared with the average summer demand of 41,000 megawatts within the entire Southwest Power Pool. The decrease of 10 megawatts as a result of the grain-to-ethanol facility would represent 0.8 percent of the production capacity in the western-central region of Kansas, but only about 0.02 percent of current summer demand in the Southwest Power Pool.

As was described in Chapter 4, Section 4.5.1.2.1, the Southwest Power Pool predicts that by 2014 the summer electrical *capacity margin* within the multi-state region covered by the Pool would drop below 12 percent, the desired level to maintain adequate reliability in the electrical distribution system. The added power production of the biorefinery would improve that condition, but with or without the grain-to-ethanol facility, the amount of improvement would be very minor.

Grain-to-Ethanol Operations Relative to the Action Alternative

Under the Action Alternative, the biorefinery would have the capability to generate electric power, but it would not be enough to supply all of its own needs and there would be none provided to the regional grid. As described in Chapter 4, Section 4.5.2.1.1, it is estimated that the biorefinery under the Action Alternative would need to pull 10 megawatts from the electrical grid during normal operations to augment its production capabilities, and at times of peak demand this would increase to 15 megawatts. With the grain-to-ethanol facility in operation, the Project's total electrical demand would increase to 20 megawatts under normal conditions and 25 megawatts at peak loads (Roach 2009e, 2009l). Section 4.5.1.2.1 describes the Southwest Power Pool as currently operating within reasonable production capacity margins, but that by 2014 the capacity margin during summer months could drop below the desired 12 percent to 11.5 percent. Even with the biorefinery and grain-to-ethanol facility having an electrical demand of 20 megawatts, this represents only about 0.05 percent of the summer load within the Southwest Power Pool. This demand would have minimal effect on the regional capacity.

5.2.4.2.2 *Natural Gas*

As with the Proposed Action and the Action Alternative, construction of the grain-to-ethanol facility would not be expected to involve any significant natural gas use. No estimates were made of the amount of natural gas that might be needed during construction because it is assumed that the tools and equipment supporting construction would not be fueled by natural gas. As a result, the discussions in this section, like those for electrical power, deal only with the impacts of operations.

Grain-to-Ethanol Operations Relative to the Proposed Action

Operation of the grain-to-ethanol facility would involve peak and average natural gas demands of 13.75 million cubic feet (389,000 cubic meters) and 3 million cubic feet (85,000 cubic meters) per day, respectively (Roach 2009e). These demands would be relative to the peak and average demands of 2.25 million cubic feet (64,000 cubic meters) and 1 million cubic feet (28,000 cubic meters) per day, respectively that Chapter 4, Section 4.5.1.2.2 describes for the Proposed Action. Combined operation of the biorefinery and the grain-to-ethanol facility would require natural gas at a peak rate of about 16 million cubic feet (450,000 cubic meters) per day and at a rate of 4 million cubic feet (110,000 cubic meters) per day during normal operations (Roach 2009e). The Hugoton area is in one of the country's major natural gas production areas. In 2007, about 370,000 million cubic feet (10,500 million cubic meters) of natural gas was produced and sold in Kansas, which equates to about 1,010 million cubic feet (28.6 million cubic meters) per day. The peak demand from the biorefinery with the grain-to-ethanol facility would be 1.6 percent of this quantity. The normal demand of 4 million cubic feet per day would be about 0.39 percent of the amount produced and sold in Kansas in 2007. The minor amounts of natural gas required by the biorefinery with the grain-to-ethanol facility would not cumulatively impact the availability of natural gas in the region.

Grain-to-Ethanol Operations Relative to the Action Alternative

Under the Action Alternative, the peak and average natural gas demands [13.75 million cubic feet (389,000 cubic meters) per day and 3 million cubic feet (85,000 cubic meters) per day, respectively] of the ethanol-to-grain facility would be relative to the peak and average demands of 1.4 million cubic feet (40,000 cubic meters) and 0.2 million cubic feet (5,700 cubic meters) per day that Chapter 4, Section 4.5.2.2.2 describes for the biorefinery. Combined operation of the biorefinery and grain-to-ethanol facility would require natural gas at a peak rate of about 15.15 million cubic feet (429,000 cubic meters) per day and at a rate of 3.2 million cubic feet (91,000 cubic meters) per day during normal operations (Roach 2009e). These numbers represent 1.5 and 0.32 percent of the 1,010 million cubic feet (28.6 million cubic meters) of natural gas produced and sold in Kansas each day. The minor amounts of natural gas required by the biorefinery under the Action Alternative and the grain-to-ethanol facility would not cumulatively impact the availability of natural gas in the region.

Other Fossil Fuels and Petroleum Products

As with the Proposed Action and the Action Alternative, construction of the grain-to-ethanol facility would not be expected to involve any meaningful use of fossil fuels or petroleum products. It is also estimated that operation of the grain-to-ethanol facility would require no additional diesel fuel over that estimated for the Proposed Action (Roach 2009f). Accordingly, there would be no cumulative effects associated with the grain-to-ethanol facility over those described in Chapter 4, Section 4.5.1.2.3 for the Proposed Action and Section 4.5.2.2.3 for the Action Alternative

5.2.4.3 Construction Materials

This evaluation is limited to the use of materials that would be committed to the construction of Project facilities. Since few such materials would be needed during operation of the biorefinery and grain-to-ethanol facility, this section does not address operations.

5.2.4.3.1 *Grain-to-Ethanol Construction Relative to the Proposed Action*

Table 5-9 provides a summary of the types and quantities of materials that would be required for construction of the grain-to-ethanol facility. Also shown in the table for comparison purposes are the types and quantities of materials required for the biorefinery under the Proposed Action. As can be seen in the table, with the exception of fencing, a high-voltage transmission line, and power poles, construction of the grain-to-ethanol facility would involve a notable increment in the total quantity of materials required.

Table 5-9. Summary of required construction materials.

Description	Quantity			Unit of measure
	Proposed Action	Action Alternative	Grain-to-ethanol facility	
Structural steel	2,500	2,200	2,500	Tons
Steel for tanks	2,400	2,400	3,900	Tons
Concrete	50,000	35,000	60,000	Cubic yards
Earthwork – fill	225,000	210,000	75,000	Cubic yards
Asphalt paving	38000	38,000	37,000	Square feet
Storm sewer pipe	2,000	2,000	500	Linear feet
Internal and external water pipe	35,000	35,000	26,000	Linear feet
Railway tracks	9,000	9,000	32,000	Linear feet
Rock sub-ballest	6,000	6,000	19,000	Cubic yards
Mechanical process piping	51,000	45,000	50,000	Linear feet
Painting	40,000	22,500	5,000	Square feet (of coverage)
Electrical and control cables	166,000	155,000	167,000	Linear feet
Cable trays	13,000	12,000	12,000	Linear feet
Fencing	20,000	20,000	0	Linear feet
Gravel	56,000	48,000	29,000	Cubic yards
Firewater piping	6,000	6,000	2,000	Linear feet
High-voltage transmission line	7,900	0	0	Linear feet
Wooden power poles	18	0	0	Each

Sources: Roach 2009f, 2009l, 2009m, 2009n.
Notes: To convert tons to metric tons, multiply by 0.90718. To convert cubic yards to cubic meters, multiply by 0.76456. To convert square feet to square meters, multiply by 0.092903. To convert feet to meters, multiply by 0.3048.

As discussed in Chapter 4, Section 4.5.1.3, DOE believes alloy and stainless steel items would be the only construction materials for which there would be a relatively high risk of unavailability in the market (Roach 2008a). The steel tanks and process piping entries are the items likely to be stainless steel and, therefore, the items most likely to be unavailable. Using the assumption that the process piping weighs about 3.7 pounds (1.7 kilograms) per linear foot (Section 4.5.1.3), the amount of stainless steel required for piping for the Proposed Action and the grain-to-ethanol facility would be 94 and 93 tons (85 and 84 metric tons), respectively. Adding these values to the amount of stainless steel for tanks, the Proposed Action would require about 2,500 tons (2,300 metric tons) of stainless steel compared with about 4,000 tons (3,600 metric tons) for the grain-to-ethanol facility. The evaluation in Section 4.5.1.3 involved a comparison of the stainless needs with the amount of applicable materials processed through the U.S. market on an annual basis, in this case during 2007. Because the grain-to-ethanol facility would be constructed after the Proposed Action was already in operation, the need for stainless steel materials would occur in a different year (likely separated by multiple years). Accordingly, for evaluation purposes, impacts from construction of the grain-to-ethanol facility would not be directly cumulative with those for the Proposed Action.

Steel production in the United States in 2007 was approximately 107 million tons (97 million metric tons) (Chapter 4, Section 4.5.1.3). Considering just the grain-to-ethanol facility, there would be about 4,000 tons (3,600 metric tons) of stainless steel and another 2,500 tons (2,300 metric tons) of structural steel required for construction. The combined quantity of 6,500 tons (5,900 metric tons) would be a minor percentage (about 0.006 percent) of the country's production capacity. As described in Section 4.5.1.3, nickel, a component of stainless steel, can make up 10 percent or more of common stainless steel formulations and is would likely affect the material's availability than the steel itself. As further described in Section 4.5.1.3, the only quantities of nickel identified as entering the U.S. market were imports [at about 138,000 tons (125,000 metric tons) in 2007] and purchased scrap [at about 228,000 tons (207,000 metric tons) in 2007 of which about 131,000 tons (119,000 metric tons) were recovered during the year]. The amount of nickel necessary to support the grain-to-ethanol construction [which would be about 10 percent of 4,000 tons, or 400 tons (360 metric tons)] would be minor in comparison with the amount in the U.S. market, but components such as nickel may be a controlling factor in the general availability of stainless steel. There would be similar, though smaller, impacts associated with obtaining materials during construction of the Proposed Action and they would have occurred in an earlier year.

5.2.4.3.2 *Grain-to-Ethanol Construction Relative to the on Alternative*

The types and quantities of materials that would be required for construction of the grain-to-ethanol facility also can be compared with the comparable materials that would be required for the Action Alternative, which are also shown in Table 5-9. As would be expected, the quantities of construction materials associated with the Action Alternative would generally be less than those for the Proposed Action. With respect to the quantities of stainless steel, however, the Proposed Action and the Action Alterative are basically the same; about 2,490 tons (2,260 metric tons) of stainless steel for the Proposed Action (Section 4.5.1.3) and about 2,480 tons (2,250 metric tons) for the Action Alternative (Section 4.5.2.3). Accordingly, the evaluation of potential impacts is no different than described above.

5.2.5 WASTES, BYPRODUCTS, AND HAZARDOUS MATERIALS

5.2.5.1 Grain-to-Ethanol Construction Relative to the Proposed Action

This section describes the construction-related incremental impacts of the grain-to-ethanol facility relative to the operations-related impacts of the Proposed Action (biorefinery). Table 5-10 lists the construction wastes associated with the addition of the grain-to-ethanol facility relative to the operations-related wastes of the Proposed Action (solid waste and wastewater generated due to the increase in worker population during the construction phase is discussed in Section 5.2.4.1).

Table 5-10. Construction-related wastes.

Type of Waste	Quantity/volume	
	Proposed Action	Grain-to-ethanol increment
Ground excess, construction and demolition debris	0	17,945 tons (16,279 metric tons)
Plastics, papers, and cartons	0	3 tons (2.7 metric tons)
Steel waste, pipes, and cables (trimmings and wastes)	0	34 tons (31 metric tons)
Metal cans (painting, chemical, oil)	0	7 tons (6.4 metric tons)
Municipal solids (inorganic)	33 tons (30 metric tons)	46 tons (42 metric tons)
Dirt and *fines* resulting from biomass processing	33,600 tons (30,500 metric tons)	0
Wastewater treatment facility sludge	7.5 to 10 gallons (28.4 to 38 liters) per minute	0
Hazardous waste	1 ton (0.9 metric ton)	0
Distiller's residual biomass solids (*stillage cake*)	116,550 dry tons (105,730 metric tons)	0
Lignin	44,709 tons (40,559 metric tons)	0
Genetically modified organisms	Included in stillage cake and syrup	0
Solid biomass boiler ash	79,671 tons (72,276 metric tons)	0

Source: Roach 2009e.

Approximately 18,035 tons (16,361 metric tons) of waste [about 100 tons (91 metric tons) per day during the 180-day construction phase] would be generated during construction of the grain-to-ethanol facility. These estimates are conservative, tending to overestimate the amount that likely would be generated because they do not reflect reductions due to recycling efforts.

Similar to the analysis in Chapter 4, Section 4.6.1.1, DOE concludes that the Stevens County landfill would not have adequate capacity to receive the wastes generated during the construction of the grain-to-ethanol facility and maintain its small arid landfill exempt status (based on the permit from the Kansas Department of Health, Bureau of Waste Management). The average disposal rate at the landfill would increase from 14.4 tons (13.1 metric tons) per day (basis provided in Section 5.2.4.1.3) to 114.4 tons (103.8 metric tons) per day from construction of the grain-to-ethanol facility. The waste stream from the operation of the biorefinery [96 tons (87 metric tons) per day] would also exceed the daily operating limit of the Stevens County landfill. The construction waste stream could be divided among various permitted landfills and transfer stations, and the bulk of the *construction and demolition waste* could be disposed of in the Grant County construction and demolition landfill. This landfill does not have a daily or annual operating limit specified on its annual permit renewal form. Dividing the construction waste among the landfills would require permission from the landfill operators. While additional waste would be generated with the construction of the grain-to-ethanol facility, there is adequate disposal capacity within the region of influence to receive these wastes and the operations-related wastes of the Proposed Action. While the grain-to-ethanol facility construction and demolition debris would occupy permitted space in the Grant County construction and demolition landfill, this waste would not significantly reduce the lifetime of this landfill. The estimated lifetime of the Seward County landfill is 42 years, based on receipt of 75,000 tons (68,000 metric tons) per year of waste. If all the biorefinery operations-related waste was taken to this landfill, it would reduce the life of the permitted landfill space by about 13 years. While this would be a significant reduction, it is likely that the waste would be split or transferred to multiple facilities to reduce the impacts to any one landfill. Therefore, there would be no adverse cumulative impacts from the disposal of construction waste from the grain-to-ethanol facility and the operations-related waste of the biorefinery if a biorefinery waste management plan was implemented.

5.2.5.2 Grain-to-Ethanol Operations Relative to the Proposed Action

This section describes the operations-related incremental impacts of the grain-to-ethanol facility relative to the operations-related impacts of the biorefinery (Proposed Action). Table 5-11 lists the operations-related wastes and byproducts associated with the addition of the grain-to-ethanol facility to the Proposed Action (solid waste and wastewater generated due to the increase in worker population during the operations phase is discussed in Section 5.2.4.2).

Table 5-11. Operations-related wastes.

Type of Waste	Quantity/volume	
	Proposed Action	Grain-to-ethanol increment
Wet distiller's grain (byproduct)	0	782,000 tons (709,000 metric tons) per year
Dry distiller's grain (byproduct)	0	152,000 tons (138,000 metric tons) per year
Dirt and fines resulting from biomass processing	33,600 tons (30,500 metric tons) per year	0
Municipal solid waste and construction debris	33 tons (30 metric tons) per year	57 tons (52 metric tons) per year
Wastewater treatment facility sludge	7.5 to 10 gallons (28.4 to 38 liters) per minute	2.5-5 gallons (9.5-19 liters) per minute
Hazardous waste	1 ton (0.9 metric tons) per year	0.5 ton (0.45 metric ton) per year
Distiller's residual biomass solids (stillage cake)	116,550 dry tons (105,730 metric tons) per year	0
Lignin	44,709 tons (40,559 metric tons) per year	0
Genetically modified organisms	Included in stillage cake and syrup	0
Solid biomass boiler ash	79,671 tons (72,276 metric tons) per year	0
Recycled process wastewater	250 gallons (950 liters) per minute	700 gallons (2,600 liters) per minute
Land-applied non-contact wastewater	225 gallons (852 liters) per minute	235 gallons (890 liters) per minute

Source: Roach 2009e.

The wet distiller's grain and dry distiller's grain would be additional byproducts generated by the grain-to-ethanol facility and would be sold to consumers as nutrients for cattle rations. Consumption of the wet distiller's grain and dry distiller's grain would require approximately 350,000 head of cattle. Active permitted beef cattle feedlots within 50 miles (80 kilometers) of the biorefinery have a combined capacity of over 640,000 head of cattle (Cattle Today Inc., n.d.; Jean n.d.; The Gale Group n.d.). This does not include beef or dairy cattle on private ranches. Many additional feedlots are outside the 50-mile region of influence; specifically, near Garden City and Dodge City, Kansas. Market research has indicated that Stevens County, Kansas, has the potential to consume from 115,000 to 350,000 tons (104,000 to 318,000 metric tons) per year of wet distiller's grain, and two adjacent counties, Texas County, Oklahoma, and

Haskell County, Kansas, each have the potential to consume from 350,000 to 1,675,000 tons (318,000 to 1,520,000 metric tons) per year (Dhuyvetter et al. 2005).

Abengoa Bioenergy has analyzed alternatives to marketing distiller's grains from the grain-to-ethanol facility (Roach 2008b). One alternative would be to increase the amount of dry distiller's grain and decrease the amount of wet distiller's grain produced at the grain-to-ethanol facility. Dry distiller's grain has a much longer shelf life than wet distiller's grain, and therefore can be shipped longer distances from the grain-to-ethanol facility. The dryer system that would convert wet distiller's grain to dry distiller's grain has the capacity to dry up to 50 percent of the distiller's grains produced by the facility. Production of additional distiller's grains as dry distiller's grain would broaden the geographic region into which the distiller's grains could be sold as byproduct.

A second alternative for distiller's grains byproduct sales or disposal would be the use of a portion of distiller's grains as a substitute for biomass feedstock to the solid biomass boiler. Although the value of distiller's grains sold as feed is higher (approximately $100 to $110 per ton on a dry-matter basis), substitution for biomass at an estimated cost of $50 to $60 per ton is more advantageous than landfill or disposal costs (Roach 2008b). Total distiller's grains production on a dry-matter basis would be approximately 780 tons (710 metric tons) per day.

Based on the above, DOE concludes there is adequate capacity of cattle feedlots within 50 miles (80 kilometers) of the grain-to-ethanol facility to consume the estimated distiller's grains output, marketing options beyond the region of influence are available, and excess distiller's grains can be used in the onsite solid biomass boiler. For these reasons, there would be no adverse cumulative impacts from the production of distiller's grains by the grain-to-ethanol facility.

Management and treatment strategies for wastes and byproducts produced by operation of the grain-to-ethanol facility would be the same as those for the biorefinery, as discussed in Chapter 4, Section 4.6.1.3. Operation of the grain-to-ethanol facility would generate additional municipal solid waste and construction debris [57 tons (52 metric tons) per year], wastewater treatment plant sludge [2.5 to 5 gallons (9.5 to 19 liters) per minute], and hazardous waste [0.5 ton (454 kilograms) per year] relative to the Proposed Action. Similar to the analysis discussed in Section 5.2.5.1, DOE concludes that the Stevens County landfill would not have adequate capacity to dispose of municipal solid waste generated from operation of the biorefinery and grain-to-ethanol facility. The operations waste streams could be divided among various permitted landfills and transfer stations within the region of influence, in which case permission from the landfill operators would be required to receive the wastes. While additional waste would be generated with the operation of the grain-to-ethanol facility, there is adequate capacity within the region of influence to receive these wastes and the operations-related wastes of the Proposed Action. Therefore, there would be no adverse cumulative impact to the landfills from the addition of the grain-to-ethanol facility if a biorefinery waste management plan was implemented.

As described for the biorefinery under the Proposed Action, the additional wastewater treatment facility sludge and non-contact wastewater would be land-applied on the buffer area as described in Chapter 4, Sections 4.6.1.2 and 4.6.1.3. The additional process wastewater [700 gallons (2,600 liters) per minute] would be treated onsite and reused in the grain-to-ethanol production process. The facility water balance and existing wastewater treatment facility would require modification to accommodate the additional process wastewater flow. There would be no discharge to the Hugoton sanitary sewer system. The additional non-contact wastewater [235 gallons (890 liters) per minute] would be land-applied as described in Section 4.6.1.2.2. The quality of the discharge water would not vary significantly from that of the Proposed Action (Table 4-19) (Roach 2009o). The additional discharge rate would require an increase in the capacity of the winter storage pond to 59,616,000 gallons (225,666,000 liters) (Roach 2009e). This storage pond would be about 2 times the size of the storage pond under the Proposed Action. The additional non-contact wastewater discharge and wastewater treatment facility sludge application would require a modification to the discharge permit by the Kansas Department of Health and Environment. DOE does not anticipate adverse cumulative impacts from land-application of the wastewater sludge and non-contact wastewater, based on the anticipated composition and quantity of the sludge and wastewater.

Management and treatment strategies for hazardous waste produced by operation of the grain-to-ethanol facility would be the same as those for the Proposed Action, as described in Chapter 4, Section 4.6.1.3. Operation of the grain-to-ethanol facility would generate approximately 0.5 ton (454 kilograms) per year of additional hazardous waste. DOE does not anticipate adverse cumulative impacts from the handling and disposal of the additional hazardous waste, as this waste would be incinerated or disposed of in permitted facilities such as the Safety-Kleen treatment/disposal facility in Denton, Texas, or the Clean Harbors treatment/disposal facility in El Dorado, Arkansas.

Table 5-12 lists the operations-related *chemicals* associated with the addition of the grain-to-ethanol facility to the Proposed Action.

Table 5-12. Operations-related chemicals.

	Annual quantity	
Chemical	Proposed Action	Grain-to-ethanol increment
Sulfuric acid (94%)	3,542 tons (3,213 metric tons)	3,150 tons (2,860 metric tons)
Sodium hydroxide (50%)	1,430 tons (1,300 metric tons)	1,192 tons (1,081 metric tons)
Aqueous ammonia (20%)	6,677 tons (6,057 metric tons)	1,680 tons (1,520 metric tons)
Urea (42%)	570 tons (520 metric tons)	3,170 tons (2,880 metric tons)
Cellulase	14,836 tons (13,459 metric tons)	0
Corn syrup	12,690 tons (11,510 metric tons)	0
Lime ($Ca(OH)_2$)	6,723 tons (6,099 metric tons)	0
Corrosion inhibitor	47 gallons (178 liters) per year	272 gallons (1,030 liters) per year
Magnesium hydroxide (50%)	122.5 tons (111.1 metric tons)	2,800 tons (2,540 metric tons)
Diammonium phosphate	5.25 tons (4.76 metric tons)	120 tons (110 metric tons)
Gasoline (ethanol denaturant)	882,000 gallons (3,340 cubic meters)	4,704,000 gallons (17,800 cubic meters)
Limestone	7,362 tons (6,679 metric tons)	0
Phosphoric acid	0	210 tons (190 metric tons)
Alpha-amylase (enzyme)	0	533 tons (484 metric tons)
Gluco-amylase (enzyme)	0	643 tons (583 metric tons)
Herbicides/pesticides	100 pounds (45 kilograms)	0

Sources: Roach 2009e, 2009d.

Based on the grain-to-ethanol chemical requirements and the availability of supplies, chemicals would need to be imported from suppliers outside the 50-mile (80-kilometer) region of influence. DOE concludes that the chemical needs of the grain-to-ethanol facility would have no adverse cumulative impacts on chemical users or suppliers within the region of influence because the annual demands for these chemicals for use in the biorefinery and grain-to-ethanol facility would be insignificant percentages of annual U.S. production quantities (Chapter 4, Section 4.6.1.4).

5.2.5.3 Grain-to-Ethanol Construction Relative to the Action Alternative

This section describes the construction-related incremental impacts of the grain-to-ethanol facility relative to the construction-related impacts of the biorefinery under the Action Alternative. Table 5-13 lists the construction-related wastes associated with the addition of the grain-to-ethanol facility to the operation of the Action Alternative (solid waste and wastewater generated due to the increase in worker population during the construction phase is discussed in Section 5.2.4.3).

Table 5-13. Construction-related wastes.

	Quantity/volume	
Type of waste	Action Alternative	Grain-to-ethanol increment
Ground excess, construction and demolition debris	0	17,945 tons (16,279 metric tons)
Plastics, papers, and cartons	0	3 tons (2.7 metric tons)
Steel waste, pipes, and cables (trimmings and wastes)	0	34 tons (31 metric tons)
Metal cans (painting, chemical, oil)	0	7 tons (6.4 metric tons)
Municipal solids (inorganic)	26 tons (24 metric tons) per year	46 tons (42 metric tons)
Dirt and fines resulting from biomass processing	8,750 tons (7,940 metric tons) per year	0
Wastewater treatment facility sludge	5-7.5 gallons (19-28.4 liters) per minute	0
Hazardous waste	1 ton (0.9 metric tons) per year	0
Distiller's residual biomass solids (stillage cake)	45,000 dry tons (41,000 metric tons) per year	0
Lignin	19,000 tons (17,000 metric tons) per year	0
Genetically modified organisms	Included in stillage cake and syrup	0
Solid biomass boiler ash	11,400 tons (10,300 metric tons) per year	0
Gasification ash	8,500 tons (7,700 metric tons) per year	0

Sources: Roach 2009e, 2009s.

Approximately 18,035 tons (16,361 metric tons) of waste [about 100 tons (91 metric tons) per day during the 180-day construction phase] would be generated during construction of the grain-to-ethanol facility. These estimates are conservative, tending to overestimate the amount that likely would be generated, because they do not reflect reductions due to recycling efforts.

Based on the analysis in Section 5.2.5.1, DOE concludes the Stevens County landfill would not have adequate capacity to receive the wastes generated during the construction of the grain-to-ethanol facility and maintain its small arid landfill exempt status (based on the permit from the Kansas Department of Health, Bureau of Waste Management). The construction waste stream could be divided, however, among various permitted landfills and transfer stations, and the bulk of the construction and demolition waste could be disposed of in the Grant County *construction and demolition waste landfill*. Dividing the construction waste among the landfills would require permission from the landfill operators. While additional waste would be generated with the construction of the grain-to-ethanol facility, there is adequate disposal capacity within the region of influence to receive these wastes and the operations-related wastes of the Action Alternative. Therefore, there would be no adverse cumulative impacts from the disposal of construction waste from the grain-to-ethanol facility and the operations-related waste of the biorefinery if a biorefinery waste management plan was implemented.

5.2.5.4 Grain-to-Ethanol Operations Relative to the Action Alternative

This section describes the operations-related incremental impacts of the grain-to-ethanol facility relative to the operations-related impacts of the Action Alternative. Table 5-14 lists the operations-related wastes and byproducts associated with the addition of the grain-to-ethanol facility.

Table 5-14. Operations-related wastes.

	Annual quantity	
Type of waste	Action Alternative	Grain-to-ethanol increment
Wet distiller's grain (byproduct)	0	782,000 tons (709,000 metric tons)
Dry distiller's grain (byproduct)	0	152,000 tons (138,000 metric tons)
Dirt and fines resulting from biomass processing	8,750 tons (7,940 metric tons)	0
Municipal solid waste and construction debris	26 tons (24 metric tons)	57 tons (52 metric tons)
Wastewater treatment facility sludge	5-7.5 gallons (19-28.4 liters) per minute	5-7.5 gallons (19-28.4 liters) per minute
Hazardous waste	1 ton (0.9 metric ton)	0.5 ton (0.45 metric ton)
Distiller's residual biomass solids (stillage cake)	45,000 dry tons (41,000 metric tons)	0
Lignin	19,000 tons (17,000 metric tons)	0
Genetically modified organisms	Included in stillage cake and syrup	0
Solid biomass boiler ash	11,400 tons (10,300 metric tons)	0
Gasification ash	8,500 tons (7,700 metric tons)	0
Recycled process wastewater	160 gallons (600 liters) per minute	700 gallons (2,600 liters) per minute
Land-applied non-contact wastewater	115 gallons (435 liters) per minute	235 gallons (890 liters) per minute

Sources: Roach 2009e, 2009q.

As discussed in Section 5.2.5.2, DOE concludes there is adequate capacity of cattle feedlots within 50 miles (80 kilometers) of the grain-to-ethanol facility to consume the estimated distiller's grains output, marketing options beyond the region of influence are available, and excess distiller's grains can be used in the onsite solid biomass boiler. For these reasons, there would be no adverse cumulative impacts from the production of distiller's grains by the grain-to-ethanol facility.

Management and treatment strategies for wastes and byproducts produced by operation of the grain-to-ethanol facility would be the same as those for the Proposed Action, as discussed in Chapter 4, Section 4.6.1.3. Operation of the grain-to-ethanol facility would generate additional municipal solid waste and construction debris [57 tons (52 metric tons) per year], wastewater treatment plant sludge [5 to 7.5 gallons

(19 to 28.4 liters) per minute], and hazardous waste [0.5 ton (454 kilograms) per year] relative to the Action Alternative. Similar to the analysis discussed in Section 5.2.5.2, DOE concludes that the Stevens County landfill would not have adequate capacity to dispose of municipal solid waste generated from operation of the grain-to-ethanol facility and operation of the biorefinery under the Action Alternative. The operations waste streams could be divided among various permitted landfills and transfer stations within the region of influence, in which case permission from the landfill operators would be required to receive the wastes. While additional waste would be generated with the operation of the grain-to-ethanol facility, there is adequate capacity within the region of influence to receive these wastes and the operations-related wastes of the Action Alternative. Therefore, there would be no adverse cumulative impact to the landfills from the disposal of municipal solid waste from the addition of the grain-to-ethanol facility if a biorefinery waste management plan was implemented.

The additional (relative to that generated by the biorefinery under the Action Alternative) wastewater treatment facility sludge and non-contact wastewater would be land-applied on the buffer area as described in Chapter 4, Sections 4.6.1.2 and 4.6.1.3. The additional process wastewater [700 gallons (2,600 liters) per minute] would be treated onsite and reused in the grain-to-ethanol production process. The facility water balance and existing wastewater treatment facility would require modification to accommodate the additional process wastewater flow. There would be no discharge to the City of Hugoton sanitary sewer system. The additional non-contact wastewater [235 gallons (890 liters) per minute] would be land-applied as described in Section 4.6.1.2.2. The quality of the discharge water would not vary significantly from that of the Action Alternative (Table 4-19) (Roach 2009o). The additional discharge rate would require an increase in the capacity of the winter storage pond to 59,616,000 gallons (225,666,000 liters) (Roach 2009e). This storage pond would be about 4 times the size of the storage pond for the Action Alternative. The additional non-contact wastewater discharge and wastewater treatment facility sludge application would require a modification to the discharge permit by the Kansas Department of Health and Environment. DOE does not anticipate adverse cumulative impacts from land-application of the wastewater sludge and non-contact wastewater based on the anticipated composition and quantity of the sludge and the wastewater.

Management and treatment strategies for hazardous waste produced by operation of the grain-to-ethanol facility would be the same as those for the Proposed Action, as described in Chapter 4, Section 4.6.1.3. Operation of the grain-to-ethanol facility would generate approximately 0.5 ton (454 kilograms) per year additional hazardous waste. DOE does not anticipate adverse cumulative impacts from the handling and disposal of the additional hazardous waste generated during operation of the grain-to-ethanol facility, as this waste would be incinerated or disposed of in permitted treatment/disposal facilities (see Section 5.2.5.2).

Table 5-15 lists the operations-related chemicals associated with the addition of the grain-to-ethanol facility to the Action Alternative. Based on the grain-to-ethanol chemical requirements and the availability of supplies, chemicals would need to be imported from suppliers outside the 50-mile (80-kilometer) region of influence, as described in Chapter 4, Section 4.6.1.4. DOE concludes that the chemical needs of the grain-to-ethanol facility would have no adverse cumulative impacts on chemical users or suppliers within the region of influence. In addition, the annual demands for these chemicals by the Action Alternative and the grain-to-ethanol facility would be insignificant percentages of annual U.S. production quantities (Section 4.6.1.4).

Table 5-15. Operations-related chemicals.

Chemical	Annual quantity	
	Action Alternative	Grain-to-ethanol increment
Sulfuric acid (94%)	5,708 tons (5,178 metric tons)	3,150 tons (2,860 metric tons)
Sodium hydroxide (50%)	475 tons (431 metric tons)	1,192 tons (1,081 metric tons)
Aqueous ammonia (20%)	1,852 tons (1,680 metric tons)	1,680 tons (1,520 metric tons)
Urea (42%)	88 tons (80 metric tons)	3,175 tons (2,880 metric tons)
Cellulase	7,581 tons (6,877 metric tons)	0
Corn syrup	525 tons (476 metric tons)	0
Lime ($Ca(OH)_2$)	3,906 tons (3,543 metric tons)	0
Corrosion inhibitor	35 gallons (130 liters) per year	272 gallons (1,030 liters) per year
Magnesium hydroxide (50%)	97 tons (88 metric tons)	2,800 tons (2,540 metric tons)
Diammonium phosphate	11 tons (10 metric tons)	120 tons (110 metric tons)
Gasoline (ethanol denaturant)	563,500 gallons (2,133 cubic meters)	4,704,000 gallons (17,800 cubic meters)
Limestone	0	7,362 tons (6,679 (metric tons)
Phosphoric acid	0	210 tons (190 metric tons)
Alpha-amylase (enzyme)	0	533 tons (484 metric tons)
Gluco-amylase (enzyme)	0	643 tons (583 metric tons)
Herbicides/pesticides	100 pounds (45 kilograms)	0

Sources: Roach 2009d, 2009e, 2009q.

5.2.6 TRANSPORTATION

5.2.6.1 Grain-to-Ethanol Construction Relative to the Proposed Action

This section describes the construction-related transportation impacts of the biorefinery and grain-to-ethanol facility relative to the construction-related impacts of the Proposed Action. Table 5-16 lists the construction material and construction waste shipments associated with the biorefinery and grain-to-ethanol facility. For the Proposed Action, it was estimated that there would be 32,075 shipments required for construction materials and construction waste. A total of 49,798 truck shipments would be required for the biorefinery and grain-to-ethanol facility, resulting in an incremental addition of 17,723 shipments.

Table 5-16. Construction material and waste shipments for the Proposed Action and the combined biorefinery and grain-to-ethanol facility under the Proposed Action.

Material	Biorefinery and grain-to-ethanol facility (truck shipments)	Proposed Action (truck shipments)	Incremental truck shipments
Construction materials	41,252	26,435	14,817
Construction and demolition wastes	8,546	5,640	2,906
Total	49,798	32,075	17,723

Source: Roach 2009p.

For the construction of the biorefinery and grain-to-ethanol facility, construction materials and waste would be shipped about 20 million round-trip miles (32 million kilometers). The estimated number of traffic fatalities from the shipment of these materials is 2.4. The incremental mileage associated with construction material and waste shipments would be 7.1 million round-trip miles (11 million kilometers) and the incremental number of traffic fatalities would be 0.85 when compared with the Proposed Action.

Commuting construction workers would travel about 9.6 million round-trip miles (15 million kilometers). The estimated number of traffic fatalities for commuting workers during the construction phase is 0.14. The incremental mileage associated with commuting construction workers would be 3.9 million round-trip miles (6.3 million kilometers) and the incremental number of traffic fatalities would be 0.058 when compared with the Proposed Action.

5.2.6.2 Grain-to-Ethanol Operations Relative to the Proposed Action

This section describes the operations-related transportation impacts of the biorefinery and grain-to-ethanol facility relative to the operations-related impacts of the Proposed Action (biorefinery only). Table 5-17 lists the operations-related biomass and grain, chemical, denatured ethanol product, and waste shipments associated with the biorefinery and grain-to-ethanol facility. These waste materials and chemicals are listed in Tables 5-11 and 5-12, respectively.

Table 5-17. Materials used or produced during operation of the biorefinery under the Proposed Action and the combined biorefinery and grain-to-ethanol facility.

Material	Biorefinery and grain-to-ethanol facility (annual shipments)	Proposed Action (annual shipments)	Incremental annual shipments
Biomass and grain	171,626	88,236	83,390
Chemicals	2,016	2,081	-65
Denatured ethanol product	4,000	632	3,368
Waste	62,900	10,761	52,139
Total	240,542	101,710	138,832

Source: Roach 2009p.

For the Proposed Action, it is estimated that there would be 101,710 annual shipments required for operations-related materials. A total of 240,542 annual shipments would be required for the combined biorefinery and grain-to-ethanol facility, resulting in an incremental addition of 138,832 annual shipments. These additional shipments primarily would be due to the grain shipments from fields to grain elevators (40,320), from grain elevators to the grain-to-ethanol facility (40,320), and the number of wet distiller's grains shipments (52,134) from the grain-to-ethanol facility to cattle feedlots. Wet distiller's grains are a byproduct produced by the grain-to-ethanol facility (Table 5-11).

The expected operations phase of the biorefinery is 30 years. For the biorefinery and grain-to-ethanol facility, operations-related materials would be shipped about 930 million round-trip miles (1.5 billion kilometers). The estimated number of traffic fatalities from the shipment of these materials is 110. The incremental mileage associated with operations-related shipments would be 680 million round-trip miles (1.1 billion kilometers), and the incremental number of traffic fatalities would be 83 when compared with the Proposed Action. These additional estimated fatalities primarily would be due to the number of grain shipments from fields to grain elevators, from grain elevators to the grain-to-ethanol facility, the number of wet distiller's grains shipments from the grain-to-ethanol facility, and the increased denatured ethanol product shipments from the grain-to-ethanol facility.

During the operations phase, commuting operations workers would travel about 91 million round-trip miles (150 million kilometers). The estimated number of traffic fatalities is 1.4. The incremental mileage associated with operations workers commuting to the grain-to-ethanol facility would be 58 million round-trip miles (93 million kilometers), and the incremental number of traffic fatalities would be 0.87 when compared with the Proposed Action.

5.2.6.3 Summary of Grain-to-Ethanol Construction and Operations Relative to the Proposed Action

During the construction and operations phases, the estimated number of traffic fatalities due to shipments to and from the combined biorefinery and grain-to-ethanol facility is 120. The majority of these estimated fatalities (110) would be due to shipments of biomass, chemicals, denatured ethanol product, and waste; most of which would be due to the relatively large number of grain shipments from fields to grain elevators, from grain elevators to the grain-to-ethanol facility, the wet distiller's grains shipments, and increased denatured ethanol product shipments. The incremental number of traffic fatalities would be 85 relative to those that are estimated to occur during operation of the biorefinery under the Proposed Action.

5.2.6.4 Road Damage

The truck traffic associated with the biorefinery and grain-to-ethanol facility would result in accelerated pavement deterioration. The degree of pavement deterioration is dependent on truck characteristics, pavement characteristics, and environmental factors. In the report *Impact of Kansas Grain Transportation on Kansas Highway Damage Costs* (Babcock and Bunch 2002), evaluated the costs associated with increased pavement deterioration from increased grain shipments by truck. These costs were estimated to be $0.17 per truck-mile ($0.11 per truck-kilometer). If it is assumed that biomass shipments (for the biorefinery) are made in a manner similar to these grain shipments, the annual costs of the pavement damage caused by the additional truck shipments of biomass would be $680,000. Grain shipments to the grain-to-ethanol facility are not likely to cause additional pavement damage because in the absence of this facility, grain shipments would have been made to grain elevators. The incremental costs of pavement damage relative to the Proposed Action would be zero because the same amount of biomass would be shipped to the biorefinery under the Proposed Action as would be shipped to the combined biorefinery and grain-to-ethanol facility.

The shipping of other materials such as chemicals and waste also would result in pavement damage. Quantitative estimates of the pavement damage caused by shipments of these other materials have not been made because the transportation system used for these materials would not be similar to the transportation system discussed in the Babcock and Bunch report (Babcock and Bunch 2002) for grain shipments, and information relevant to such estimates is otherwise not available. However, estimating the highway pavement damage costs attributed to truck (such as, tractor-trailers) traffic is the subject of research efforts being conducted at the Mid-American Transportation Center.

5.2.6.5 Grain-to-Ethanol Construction Relative to the Action Alternative

This section describes the construction-related transportation impacts of the combined biorefinery and grain-to-ethanol facility relative to the construction-related impacts of the biorefinery under the Action Alternative. Table 5-18 lists the construction material and construction waste shipments associated with the biorefinery and grain-to-ethanol facility as well as the biorefinery under the Action Alternative. For the Action Alternative, it was estimated that 28,573 truck shipments would be required for construction materials and construction waste. A total of 46,296 truck shipments would be required for the biorefinery and grain-to-ethanol facility, resulting in an incremental addition of 17,723 shipments.

Table 5-18. Construction material and waste shipments for the biorefinery under the Action Alternative and the combined biorefinery and grain-to-ethanol facility.

Material	Biorefinery and grain-to-ethanol facility (truck shipments)	Biorefinery (truck shipments)	Incremental truck shipments
Construction materials	38,314	23,497	14,817
Construction and demolition wastes	7,982	5,076	2,906
Total	46,296	28,573	17,723

Source: Roach 2009p.

For the construction of the biorefinery and grain-to-ethanol facility, construction materials and waste would be shipped about 19 million round-trip miles (31 million kilometers). The estimated number of traffic fatalities from the shipment of these materials by truck is 2.2. The incremental mileage associated with construction material and waste shipments would be 7.1 million round-trip miles (11 million kilometers), and the incremental number of traffic fatalities would be 0.85 when compared with those estimated for the Action Alternative.

Commuting construction workers would travel about 9.0 million round-trip miles (14 million kilometers). The estimated traffic fatalities for commuting workers during the construction phase is 0.14. The incremental mileage associated with commuting workers would be 3.9 million round-trip miles (6.3 million kilometers), and the incremental number of traffic fatalities would be 0.058 when compared with the Action Alternative.

5.2.6.6 Grain-to-Ethanol Operations Relative to the Action Alternative

This section describes the operations-related transportation impacts of the biorefinery and grain-to-ethanol facility relative to the operations-related impacts of the Action Alternative. Table 5-19 lists the operations-related biomass and grain, chemical, denatured ethanol product, and waste shipments associated with the biorefinery and grain-to-ethanol facility. These waste materials and chemicals are listed in Tables 5-11 and 5-12, respectively.

For the Action Alternative, the estimated annual shipments required for operations-related materials is 30,501. A total of 169,333 annual shipments would be required for the biorefinery and grain-to-ethanol facility, resulting in an incremental addition of 138,832 annual shipments. These additional shipments primarily would be due to the number of grain shipments from fields to grain elevators (40,320), from grain elevators to the grain-to-ethanol facility (40,320), and the number of wet distiller's grains shipments to cattle feedlots (52,134). Wet distiller's grains are a byproduct produced at the biorefinery and grain-to-ethanol facility (see Table 5-11).

The expected operations phase of the biorefinery is 30 years. For the biorefinery and grain-to-ethanol facility, operations-related materials would be shipped about 770 million round-trip miles (1.2 billion kilometers). The estimated number of traffic fatalities from shipment of these materials is 94. The incremental mileage associated with operations-related shipments of the grain-to-ethanol facility would be 680 million round-trip miles (1.1 billion kilometers), and the incremental number of traffic fatalities

Table 5-19. Materials used or produced during operation of the biorefinery under the Action Alternative and the combined biorefinery and grain-to-ethanol facility.

Material	Biorefinery and grain-to-ethanol facility(annual shipments)	Action Alternative (annual shipments)	Incremental annual shipments
Biomass and grain	110,624	27,234	83,390
Chemicals	701	766	-65
Denatured ethanol products	3,789	421	3,368
Waste	54,219	2,080	52,139
Total	169,333	30,501	138,832

Source: Roach 2009p.

would be 83 when compared with the Action Alternative. These estimated additional fatalities primarily would be due to the number of grain shipments from fields to grain elevators, from grain elevators to the grain-to-ethanol facility, the number of wet distiller's grains shipments from the grain-to-ethanol facility, and increased denatured ethanol product shipments from the grain-to-ethanol facility.

During the operations phase, commuting operations workers would travel about 84 million round-trip miles (140 million kilometers). The estimated number of traffic fatalities for commuting workers during the operations phase of the combined biorefinery and grain-to-ethanol facility is 1.3. The incremental mileage associated with commuting operations workers would be 58 million round-trip miles (93 million kilometers) and the incremental number of traffic fatalities would be 0.87 when compared with the biorefinery under the Action Alternative.

5.2.6.7 Summary of Grain-to-Ethanol Construction and Operations Relative to the Action Alternative

During the construction and operations phases, the estimated number of traffic fatalities due to shipments to and from the combined biorefinery and grain-to-ethanol facility is 97. The majority of these estimated fatalities (94) would be due to shipments of biomass, chemicals, denatured ethanol product, and waste; most of which would be due to the relatively large number of grain shipments from fields to grain elevators, from grain elevators to the grain-to-ethanol facility, the wet distiller's grains shipments, and increased denatured ethanol product shipments. The incremental number of traffic fatalities would be 85 relative to those estimated for the Action Alternative.

5.2.6.8 Road Damage

The truck traffic associated with the biorefinery and grain-to-ethanol facility would result in accelerated pavement deterioration. As discussed above in Section 5.2.6.4, the costs associated with increased pavement deterioration from increased grain shipments by truck were estimated to be $0.17 per truck-mile ($0.11 per truck-kilometer). If it is assumed that biomass shipments to the biorefinery are made in a manner similar to grain shipments to the grain-to-ethanol facility, the annual costs of the pavement damage caused by the shipments of biomass would be $210,000. Grain shipments to the grain-to-ethanol facility would cause no additional pavement damage because in the absence of these facilities, grain shipments would have been made to grain elevators. The incremental costs of pavement damage relative to the Action Alternative would be zero because the same amount of biomass would be shipped to the biorefinery under the Action Alternative as would be shipped to the combined biorefinery and grain-to-ethanol facility.

The shipping of other materials, such as chemicals and waste, also would result in pavement damage. Quantitative estimates of the pavement damage caused by shipments of these other materials have not been made because the transportation system used for these materials would not be similar to the transportation system discussed in the Babcock and Bunch report (Babcock and Bunch 2002) for grain shipments, and information relevant to such estimates is not otherwise available.

5.2.6.9 Car and Truck Traffic

The cumulative impacts of increased car and truck traffic were analyzed in a traffic impact analysis prepared for Abengoa Bioenergy (TranSystems 2008). This analysis is discussed in Chapter 4, Section 4.7.1.1 of this EIS. In the analysis, traffic conditions near the Biorefinery Project site are described with respect to level of service. *Level of service* is a qualitative measure describing operational conditions within a traffic stream based on service measures such as speed and travel time, freedom to maneuver, traffic interruptions, comfort, and convenience (TRB 2000). Level of service is rated from A to F: service level A represents the most desirable condition, with free-flow movement of traffic and minimal delays, and service level F generally indicates severely congested conditions, with excessive delays to motorists. Intermediate grades of B, C, D, and E reflect incremental increases in the average delay per stopped vehicle. Delay is measured in seconds per vehicle. Table 3.17 in Chapter 3 of this EIS shows the upper limit of delay associated with each level of service for signalized and unsignalized intersections (TranSystems 2008).

In addition to level of service, the traffic impact analysis evaluated the ratio of volume-to-capacity to assess the overall capacity of the intersection or unsignalized movement. The ratio of volume-to-capacity reflects, regardless of delay, the ability to accommodate the existing or projected traffic volumes over the course of a peak hour. A volume-to-capacity ratio of 1.00 means that an intersection or road is operating at 100 percent of its capacity (TranSystems 2008).

The level of service rating deemed acceptable varies by community, type of road or intersection, and traffic control device. In communities similar to Hugoton, Kansas, service level C for signalized intersections is acceptable. However, at unsignalized intersections, service levels D, E, and F are accepted for low to moderate traffic volumes, where the installation of a traffic signal is not warranted by the conditions at the intersection, or the location has been deemed undesirable for signalization for other reasons (TranSystems 2008).

The traffic impact analysis looked at anticipated traffic from the Biorefinery Project site and the existing traffic at 11 intersections near the Project site for the peak hours during mornings and afternoons. The evaluation was conducted for two time periods: (1) at the beginning of biorefinery operations, and (2) after 20 years of operations to account for future population growth in the area.

The traffic study discussed in Chapter 4, Section 4.7.1.1 was based on 1,078 employee trips and truck shipments per day. During the construction and operation of the biorefinery and grain-to-ethanol facility, there would be a similar number of shipments per day. Therefore, the cumulative impacts on traffic of the combined biorefinery and grain-to-ethanol facility would be similar to those presented in Section 4.7.1.1 (the Proposed Action impacts). Based on the traffic impact analysis, no roadway improvements were identified as necessary to help truck and employee traffic access the biorefinery and grain-to-ethanol facility.

5.2.6.10 Rail Traffic

From 2003 to 2007, there was an average of 35,000 train-miles (56,000 kilometers) per year of rail traffic on the Cimarron Valley Railroad (FRA 2008). Based on an average haul length of 59 miles (95 kilometers) (Babcock and Sanderson 2006), this would be equivalent to about 600 trains per year, or about 2 trains per day. As a result of operation of the biorefinery and grain-to-ethanol facility, it is estimated that an additional 4,476 carloads per year of denatured ethanol and waste would be shipped from the facilities, as well as an additional 3,175 carloads per year of chemicals and grain shipped to the facilities. Based on an average train length of 26 cars (Babcock and Sanderson 2006), this is equivalent to about 170 additional trains per year carrying denatured ethanol and waste, and about 120 additional trains per year carrying chemicals and grain, or a total of 290 additional trains per year. This is about 25 additional trains every month. The Cimarron Valley Railroad could also increase the length of existing trains, which would result in fewer additional trains. The capacity of a single-track rail line is generally in the range of 40 to 60 trains per day. Therefore, the additional rail traffic from the biorefinery and grain-to-ethanol facility would not adversely affect Cimarron Valley Railroad operations.

5.2.7 AESTHETICS

5.2.7.1 Visual Resources

5.2.7.1.1 *Grain-to-Ethanol Facility Construction*

Construction of a grain-to-ethanol facility would occur while the biorefinery under the Proposed Action or Action Alternative is operational. Therefore, impacts resulting from releases of visible emissions, mainly fugitive dust, due to construction activities would occur in addition to visual emission sources identified from operation of the biorefinery. Many of the same control practices applied during the construction and operation of the facility under the Proposed Action or Action Alternative would be applied to the construction and operations activities of the grain-to-ethanol facility to minimize visual impacts. These include watering and chemical stabilization of disturbed soils and management practices to avoid vehicle trackout, unnecessary idling or operation of construction equipment, and use of well-maintained equipment to minimize dust and diesel particulate exhaust. Further, while new in-plant haul roads would be constructed for the grain-to-ethanol facility, some of the in-plant haul roads already would be paved. Therefore, construction of the grain-to-ethanol facility would result in a slight increase of the visual impacts that would occur during operation of the grain-to-ethanol facility under the Proposed Action or Action Alternative. In addition, the equipment used on or around the facility to support the construction activities would contribute to an increased visibility of vehicles and structures such as cranes, trucks on the roads, and traffic. However, the increased visibility of vehicles and construction equipment would be temporary in nature.

5.2.7.1.2 *Grain-to-Ethanol Facility Operations*

Since the grain-to-ethanol facility would be in addition to the biorefinery under either the Proposed Action or Action Alternative, the construction of additional structures to house the grain-to-ethanol facility would be necessary. A rendering of the biorefinery under the Proposed Action with the grain-to-ethanol facility, as seen from the northwest, is shown in Figure 5-4. In comparison with the rendering of the Proposed Action (Chapter 4, Figure 4-11) or the Action Alternative (Figure 4-14), the rendering in Figure 5-4 contains an additional group of structures on the south end of the plant layout. Some of the additional structures, such as the grain storage silos, would be approximately 100 feet (30 meters) tall.

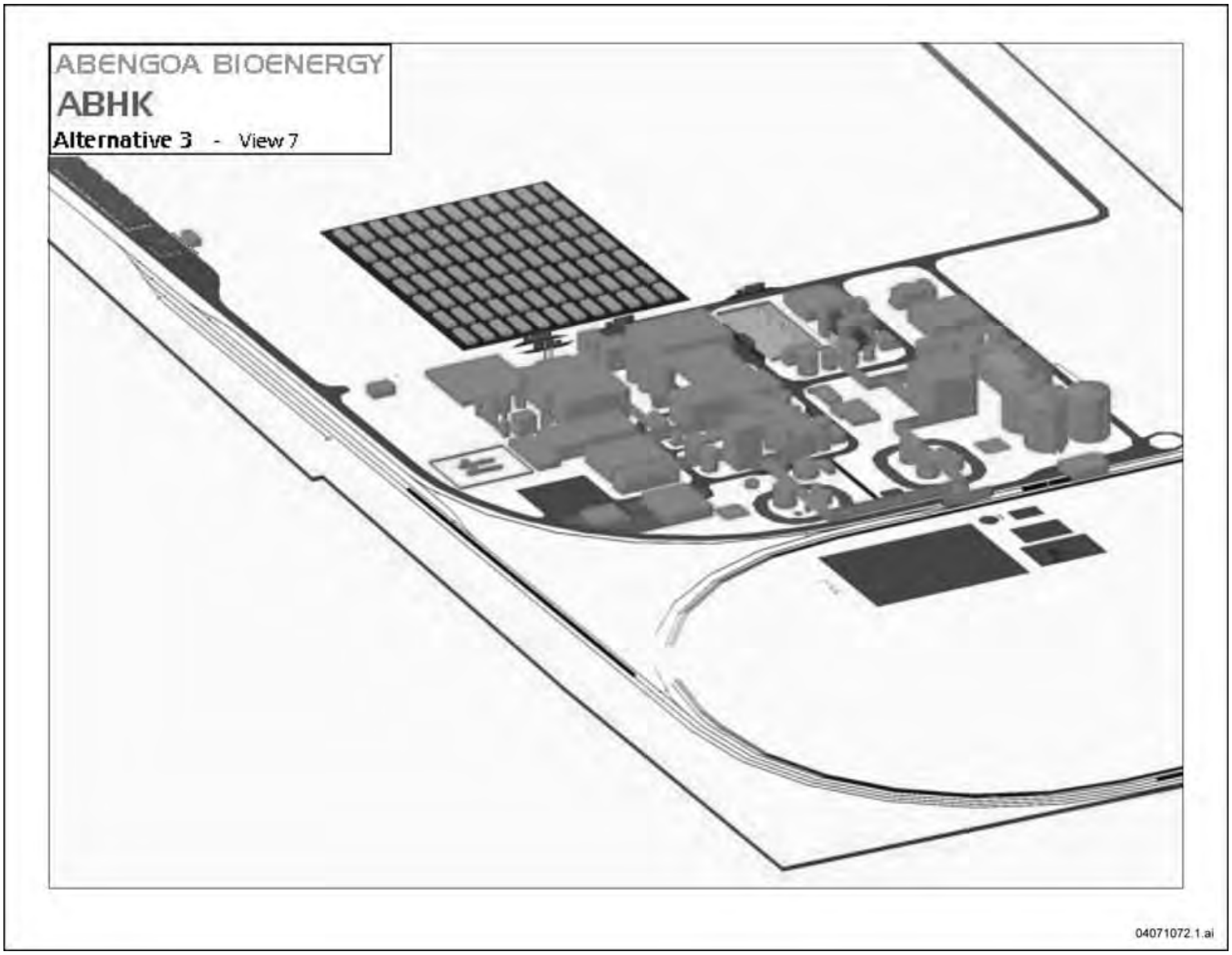

Figure 5-4. Rendering as seen from northwest of the biorefinery (Proposed Action) with the grain-to-ethanol facility.

Therefore, the additional structures would result in cumulative visual impacts to the surrounding area beyond those of the impacts from the Proposed Action or Action Alternative. These structures would be visually similar to the grain silos, chemical tanks, and other structures located adjacent to the biorefinery and would be visible from surrounding vantage points, such as the city of Hugoton and the Forewinds Golf Course. However, because the grain-to-ethanol facility would be to the south of the biorefinery under the Proposed Action or Action Alternative, the new structures would not be closer to a viewer in Hugoton. Thus, a viewer in Hugoton would see an increased amount of structures, but they would not appear closer.

The grain-to-ethanol facility would operate 24 hours per day, 350 days per year and would therefore require night lighting in addition to the lighting required by the Proposed Action or Action Alternative. Night lighting for the grain-to-ethanol facility would be similar to that used under the Proposed Action or Action Alternative; however, increased lighting within a localized area at the Biorefinery Project site would result in noticeable cumulative visual impacts to viewers within the city of Hugoton. The use of downward-facing or directional lighting and the minimum amount of lighting needed for safe operation would aid in mitigating impacts from this additional night lighting.

5.2.7.2 Noise

5.2.7.2.1 *Grain-to-Ethanol Facility Construction*

Construction of a grain-to-ethanol facility would take place while the biorefinery under the Proposed Action or Action Alternative is operational. *Noise* impacts to workers under the Proposed Action or Action Alternative are described in Chapter 4, Section 4.8.2 and would not cause hearing loss with institution of proper hearing protection procedures and compliance with occupational health and safety requirements. Some workers may experience incremental noise impacts from biorefinery operations and construction of the grain-to-ethanol facility. Construction impacts would include noise from large machinery such as trucks, cranes, bulldozers, dumpers, front-loaders, and excavators. Contractors using construction equipment at the Biorefinery Project site would comply with regulatory requirements and use the principle of controlling noise at the source whenever practical. Best management practices for limiting construction noise would also be employed, as described in Chapter 7 of this EIS. Given compliance with occupational health and safety requirements (29 CFR 1910.95) and employment of other best management practices, no cumulative noise impacts to biorefinery operations workers or construction workers from construction of the grain-to-ethanol facility would be expected.

The nearest offsite receptor, a residence located 0.6 mile (1 kilometer) from the biorefinery at the northwest boundary of the Biorefinery Project site, would experience construction-related noise of about 56 decibels (dBA). Noise from ongoing biorefinery operations, in contrast, would *attenuate* to below background levels (Chapter 4, Section 4.8.2.2.2) before reaching the residence. The cumulative sound level is only slightly higher than the U.S. Environmental Protection Agency-recommended outdoor sound level of no more than 55 dBA to avoid annoyance (EPA 1978). Noise and sound levels would be typical of new construction activities and would be intermittent. This impact (annoyance) would be lessened by confining construction activities to normal working hours (during which time background noise at the residence is estimated to be about 44 dBA), and employing noise-controlled construction equipment to the extent possible. Some work may need to occur outside normal working hours. This work would typically be less noisy, for example, x-ray examination of welds on pipes. If construction work was necessary between 7 p.m. and 7 a.m., best management practices such as the following noise abatement measures would be employed: silencers on equipment and tools, sound barriers at specific points around work areas, and avoidance of noisy work outside of buildings. On balance, however, the nearest residence may experience minor annoyance from the construction noise; however, the cumulative impact would be small because of the magnitude of the estimated noise level (56 dBA) and because the noise would be limited to the construction period.

Noise also would occur from truck traffic. Trucks for material shipments to the construction site of the grain-to-ethanol facility would be in addition to trucks traveling to and from the biorefinery for operations under either the Proposed Action or Action Alternative. Trucks traveling along US-56 from the northeast would pass through a residential area in the northwest corner of the city of Hugoton. Assuming all trucks for construction shipments would use this route, these residences would experience an additional 11 truck passes between 7 a.m. and 9 p.m. relative to shipments under the Proposed Action for a total of 99 truck passes during this period. This is the equivalent of an average of one truck every 8.5 minutes (under the Action Alternative, there would be an additional 11 truck passes for a total of 38 truck passes, or one truck every 22 minutes). The typical noise level for trucks at highway speed [approximately 55 miles (88 kilometers) per hour] is approximately 90 dBA. Trucks passing through the city of Hugoton would be traveling at a lower speed, so lower noise levels would be typical, but would still be sufficient to interfere frequently with outdoor conversations and potentially cause annoyance indoors.

5.2.7.2.2 *Grain-to-Ethanol Facility Operations*

Operation of the grain-to-ethanol facility would produce slightly higher noise levels compared with the Proposed Action or Action Alternative. Areas within the biorefinery and grain-to-ethanol facility with the highest noise levels would be the Milling Area (106 dBA), the Biomass Receiving Area (100 dBA), the Grain Receiving Area (100 dBA), and the Steam Generation System (99 dBA). Noise impacts to workers at the biorefinery and the grain-to-ethanol facility would not cause hearing loss given compliance with occupational health and safety requirements (29 CFR 1910.95).

To calculate the cumulative noise impacts to the public from operations, the four noisiest areas in the combined biorefinery and grain-to-ethanol facility were combined, resulting in a maximum estimated sound level of 108 dBA, compared with 105 dBA for just the biorefinery under the Proposed Action or Action Alternative. Two of these areas (the Milling Area and the Steam Generation System) would operate 24 hours per day, while the Grain Receiving Area and the Biomass Receiving Area would operate 16 hours per day. To be conservative, however, this analysis assumed that all four areas would operate 24 hours per day. The *day-night average sound level* was estimated to be 78 dBA at 50 feet (15 meters). At 0.6 mile (1 kilometer) (location of the nearest residence) this level would attenuate to 42 dBA. This does not account for any additional attenuation from enclosures or buildings. Design plans are to have all biomass grinding and corn-milling operations in enclosures or buildings. Because the noise level at this residence would not increase above background level, no annoyance from cumulative noise impacts from the biorefinery and grain-to-ethanol facility is expected.

The frequency of noise exposure from truck traffic would increase by about 2.5 times over the Proposed Action and about 6 times over the Action Alternative from the addition of the grain-to-ethanol facility. During operations, an increase of 264 trucks per day over the Proposed Action or Action Alternative is expected. Table 5-20 summarizes the number of trucks per day, as well as the time between truck passes for four potential routes to the biorefinery for the Proposed Action, Action Alternative, grain-to-ethanol facility, as well as the cumulative impacts from the grain-to-ethanol facility with the Proposed Action or Action Alternative.

DOE assumed 50 percent of all trucks would travel to the biorefinery from the north and east on US-56 to Road P. These trucks would pass through the residential area in the northwest corner of the city of Hugoton between 7 a.m. and 9 p.m. This is the equivalent of an average of one truck approximately every 3.8 minutes during this period when combined with the Proposed Action and one truck approximately every 5.3 minutes when combined with the Action Alternative. The typical noise level for trucks at highway speed [approximately 55 miles (88 kilometers) per hour] is approximately 90 dBA. Trucks passing through the city of Hugoton would be traveling at a lower speed, so lower noise levels would be typical, but would still be sufficient to interfere with outdoor conversations and cause annoyance indoors, and because the truck traffic would be almost constant, it likely would be very annoying.

Trucks traveling from the south-east along US-56/K-51 would pass through the southern part of the city of Hugoton. Noise sensitive receptors along this route include the Stevens County Hospital, as well as several schools, residences, and places of worship. The Department assumed 20 percent of all trucks

Table 5-20. Summary of truck traffic along various transportation routes.

Route to biorefinery	Proposed Action		Action Alternative		Grain-to-ethanol facility		Proposed Action and grain-to-ethanol facility		Action Alternative and grain-to-ethanol facility	
	Trucks per day	Time between truck passes (min)	Trucks per day	Time between truck passes (min)	Trucks per day	Time between truck passes (min)	Trucks per day	Time between truck passes (min)	Trucks per day	Time between truck passes (min)
From north-east via US-56 to Road P	88	9.5	27	31	132	6.4	220	3.8	159	5.3
From north-west on Road P	9	93	3	280	13	65	22	38	16	53
From south-west on US-56/ K-51[a]	44	19	13	65	66	13	110	7.6	79	11
From south-east on US-56/ K-51[a]	35	24	11	76	53	16	88	9.5	64	13

a. Trucks using these routes would likely travel north on Road 10 to Road P to access the biorefinery and would therefore pass by the residence at the northwest boundary of the Project site.

would use this route and these receptors would experience 88 truck passes between 7 a.m. and 9 p.m. This equates to approximately one truck every 9.5 minutes. These trucks would continue west on US-56/K-51 and likely travel north on Road 10 to Road P to access the biorefinery, and thus would pass by the residence at the northwest boundary of the Biorefinery Project site. In addition, trucks traveling from the south and west on US-56/K-51 would likely travel north on Road 10 to Road P, and trucks traveling from the north-west on Road P also would pass this residence. Assuming 25 percent of all trucks traveled from the south-west and 5 percent of trucks traveled from the north-west, this residence would experience 50 percent of all truck traffic, or a total of 220 truck passes between 7 a.m. and 9 p.m. under the Proposed Action with the grain-to-ethanol facility. This equates to approximately one truck every 3.8 minutes. Under the Action Alternative and the grain-to-ethanol facility, this residence would experience a total of 159 truck passes between 7 a.m. and 9 p.m., equating to approximately one truck every 5.3 minutes. Most of the trucks passing by this residence would be turning and would be traveling at a lower speed, with lower noise levels, but would still be sufficient to interfere with outdoor conversations and potentially cause annoyance indoors; because of the frequency of the truck traffic, the noise would be very annoying.

The frequency of noise exposure from rail traffic also would increase from the addition of the grain-to-ethanol facility. An estimated 7,651 rail cars would be used per year during operation of the biorefinery and grain-to-ethanol facility. This is about 6 times more rail cars than for the Proposed Action and about 10 times more than for the Action Alternative. Based on the average train length of 26 cars, this is equivalent to about 294 trains per year, compared with 51 trains per year for the Proposed Action and 28 trains per year for the Action Alternative. A rail loop would be built on the western portion of the biorefinery area that would come within approximately 500 feet (150 meters) of the residence at the northwest property boundary (Figure 5-5). The movement of rail cars on this loop would increase the noise in this area and potentially cause annoyance at the residence. The main components of rail noise are the exhaust of the diesel engines, cooling fans, general engine noise, horn noise, and the wheel-rail interaction. The amount of noise created by the wheels on the rails depends on train speed; the amount of engine noise depends on the throttle setting. Horn noise would not be expected since grade crossings to warn motorist or pedestrians of approaching trains would not be necessary.

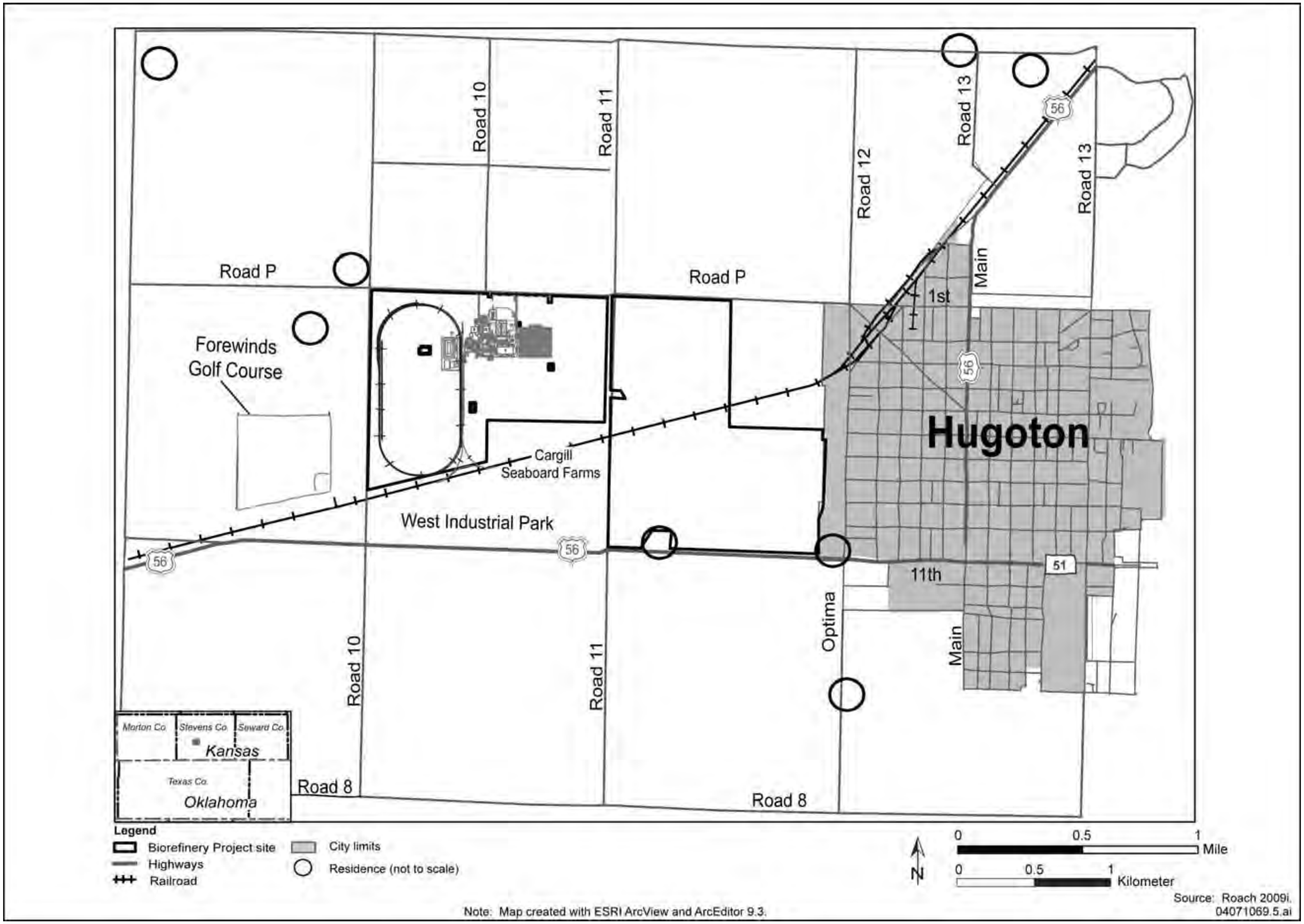

Figure 5-5. Biorefinery Project site showing rail loop and nearby residences.

On balance, the noise produced by the combined operation of the biorefinery and grain-to-ethanol facility would be indistinguishable from background at the residence nearest to the Biorefinery Project site [about 0.6 mile (1 kilometer) from the facilities]. In contrast, however, the cumulative noise produced by passing trucks and trains would be of sufficient frequency and magnitude so as to interfere with outdoor conversation and would be an annoyance indoors to the nearest resident, as well as to other receptors (other residents, places of worship, schools) along the transportation routes.

5.2.7.3 Odor

This section describes the cumulative impacts to the public from odorous air emissions from construction and operation of the biorefinery (Proposed Action, Action Alternative) and the grain-to-ethanol facility. Cumulative impacts during construction of the grain-to-ethanol facility and operations under the Proposed Action and Action Alternative are discussed in Section 5.2.7.3.1. Sections 5.2.7.3.2 and 5.2.7.3.3 provide estimates of the cumulative odor impacts from operation of the biorefinery and grain-to-ethanol facility under the Proposed Action and Action Alternative, respectively.

The air dispersion model used to estimate these impacts involves mathematical simulations of the interactions of sources of odor, physical structures of the involved facilities, and various types of data. Determining the impacts to the public from odorous emissions from the biorefinery and grain-to-ethanol facility requires a “combined” air dispersion analysis, and therefore, unlike most other resource areas in this chapter, it is not feasible to present the incremental impact of the addition of the grain-to-ethanol facility (in other words, the cumulative impact from odors is not the simple sum of the impacts under the Proposed Action or Action Alternative plus those of the grain-to-ethanol facility).

5.2.7.3.1 *Grain-to-Ethanol Construction*

Construction of a grain-to-ethanol facility would occur while the biorefinery under the Proposed Action or Action Alternative is operational. Odorous emissions from the grain-to-ethanol construction would be temporary and limited to diesel equipment exhaust. The use of well-maintained construction equipment, having appropriate emission controls, would reduce tailpipe emissions, including odorous compounds. Because operation of the biorefinery under either the Proposed Action or Action Alternative is not expected to create odors that would be detectable outside of the biorefinery parcel fence line, additional odors created by the diesel construction equipment would not be expected to create any adverse cumulative impacts outside of the fence line.

5.2.7.3.2 *Grain-to-Ethanol Operations Relative to the Proposed Action*

The biorefinery processes under the Proposed Action would create odorous compounds, as described in Chapter 4, Section 4.8.3. The addition of the grain-to-ethanol facility also would introduce additional sources of odorous compounds including grain fermentation and distillation, drying the wet distiller’s grain with solubles, storage and loadout of wet distiller’s grain with solubles, and storage and loadout of wet distiller’s grain with solubles. The wet distiller’s grain would be stored temporarily on a concrete pad prior to shipping and would be shipped offsite or dried within one to two days, which would tend to minimize odors. The grain-to-ethanol facility would require a source of steam production that is separate from the steam production in the Proposed Action. The additional boilers in the grain-to-ethanol facility also would be additional sources of odorous compounds. Besides the additional sources of odorous compounds, the grain-to-ethanol facility also would increase the amount of odorous compounds emitted from storage tanks and ethanol loadout because of the increase in production of denatured ethanol [the grain-to-ethanol facility would produce 96 millions gallons (363 million liters) of ethanol per year]. Lastly, other sources of odorous compounds from the Proposed Action, such as emergency equipment and power generation, would still exist, but the odor concentrations from these sources would not increase from the addition of the grain-to-ethanol facility.

Dispersion modeling (using the April 2009 biorefinery design) was performed to determine if odorous compounds from the biorefinery and grain-to-ethanol facility would be detectable offsite. The odor analysis assumed that proposed emission controls, such as wet scrubbers, were in place and operational. Additional details of the analytical approach, parameters used, receptor locations, and other information relevant to the dispersion modeling are provided in Appendix F of this EIS. Table 5-21 lists the odorous compounds along with their *odor threshold* concentration value and the maximum model results.

Table 5-21. Summary of odor model results for the biorefinery (Proposed Action) and grain-to-ethanol facility.

Odorous compound	Odor threshold value	Maximum model result ($\mu g/m^3$)	Location of maximum
1,3 Butadiene	0.45 ppm (1.0 mg/m^3)[a]	0.039	north fence line
Acetaldehyde	0.050 ppm (0.090 mg/m^3)[b]	140	north fence line
	0.050 ppm (0.090 mg/m^3)[b]	51	West Industrial Park
	0.050 ppm (0.090 mg/m^3)[b]	23	Hugoton resident #1
Acetone	3.6 ppm (8.6 mg/m^3)[a]	0.023	north fence line
Acrolein	0.16 ppm (.37 mg/m^3)[b]	14	north fence line
Ammonia	5.2 ppm (3.6 mg/m^3)[b]	11	north fence line
Benzene	12 ppm (38 mg/m^3)[b]	100	north fence line
Biphenyl	0.00083 ppm (0.0052 mg/m^3)[b]	0.012	north fence line
Butane	2,700 ppm (6,400 mg/m^3)[b]	1.8	south fence line
Carbon disulfide	0.11 ppm (0.34 mg/m^3)[b]	0.015	north fence line
Carbon tetrachloride	96 ppm (600 mg/m^3)[b]	2.4×10^{-4}	north fence line
Chlorine	0.08 ppm (0.23 mg/m^3)[a]	4.9×10^{-3}	north fence line
Chlorobenzene	0.68 ppm (3.1 mg/m^3)[b]	4.1×10^{-3}	north fence line
Chloroform	85 ppm (410 mg/m^3)[b]	3.5×10^{-3}	north fence line
Cumene	0.008 ppm (0.04 mg/m^3)[a]	0.059	north fence line
Dichlorobenzene	0.30 ppm (1.8 mg/m^3)[b]	1.0×10^{-3}	south fence line
Dichloromethane	158 ppm (550 mg/m^3)[a]	0.036	north fence line
Ethane	120,000 ppm (150,000 mg/m^3)[b]	2.7	south fence line
Ethanol	49 ppm (93 mg/m^3)[a]	1,100	north fence line
Ethylbenzene	2.3 ppm (10 mg/m^3)[b]	0.029	north fence line
Formaldehyde	0.83 ppm (1.0 mg/m^3)[b]	69	north fence line
Furfural	0.078 ppm (0.31 mg/m^3)[b]	12	north fence line
Hexane	130 ppm (460 mg/m^3)[b]	1.6	south fence line
Hydrogen chloride	0.77 ppm (1.1 mg/m^3)[b]	1.6	north fence line
Methanol	4.2 ppm (5.5 mg/m^3)[a]	140	north fence line
Naphthalene	0.038 ppm (0.20 mg/m^3)[a]	0.076	north fence line

Table 5-21. Summary of odor model results for the biorefinery (Proposed Action) and grain-to-ethanol facility (continued).

Odorous compound	Odor threshold value	Maximum model result ($\mu g/m^3$)	Location of maximum
Nitrogen dioxide	0.39 ppm (0.73 mg/m^3)[b]	1,400	north fence line
	0.39 ppm (0.73 mg/m^3)[b]	460	golf course
	0.39 ppm (0.73 mg/m^3)[b]	240	Hugoton resident #1
Pentane	400 ppm (1,200 mg/m^3)[b]	2.3	south fence line
Phenol	0.040 ppm (0.15 mg/m^3)[b]	6.3×10^{-3}	north fence line
Propane	16,000 ppm (29,000 mg/m^3)[b]	1.4	south fence line
Propylene	22.5 ppm (38 mg/m^3)[a]	360	north fence line
Styrene	0.017 ppm (0.073 mg/m^3)[a]	0.23	north fence line
Sulfur dioxide	1.1 ppm (2.9 mg/m^3)[b]	84	north fence line
Toluene	0.021 ppm (0.08 mg/m^3)[a]	37	north fence line
Vinyl chloride	3,000 ppm (7,700 mg/m^3)[b]	2.2×10^{-3}	north fence line
Xylene	0.35 ppm (1.5 mg/m^3)[a,c]	25	north fence line

a. AIHA 1989.
b. Amoore 1983.
c. Lowest value of the three isomers (m-Xylene)
mg/m^3 = milligrams per cubic meter.
ppm = parts per million.
$\mu g/m^3$ = microgram per cubic meter.

The biorefinery design parameters and associated values necessary to estimate odor-related impacts will not be finalized until after publication of this draft Abengoa Biorefinery EIS. The description of the biorefinery and its operations discussed in Chapter 2 represent the latest available information (as of July 2009). The odor-related compound concentrations shown in Table 5-21, however, represent the design parameters and associated values of an earlier biorefinery design (April 2009).

In general, the most recent design (July 2009) would result in a relative increase in the amount of biomass stored and processed at the biorefinery, as well as a relative increase in the production of ethanol and electricity and associated byproducts and wastes. DOE anticipates that the final design parameters and associated values are likely to result in higher odor compound concentrations, but preliminary calculations by DOE show they would not increase to levels above the odor threshold values.

Of all the compounds that were modeled, only acetaldehyde and nitrogen dioxide exceeded the referenced odor threshold values at the fence line of the biorefinery parcel. However, when modeled at offsite locations where people are more likely to be physically located, such as the golf course, homes, parks, schools, and nearby businesses, the concentration of both acetaldehyde and nitrogen dioxide dropped below the referenced odor threshold values. Even when nitrogen dioxide emissions were increased by nearly 40 percent, as is anticipated to occur with the newer biorefinery design parameters, a corresponding 40-percent increase in nitrogen dioxide concentration would not exceed the odor threshold at the golf course or homes. Thus, while odors may be detectible at the fence line, residents of Hugoton, workers at the industrial park, and golfers should not be able to detect odors from the biorefinery and grain-to-ethanol facility.

5.2.7.3.3 *Grain-to-Ethanol Facility Operations Relative to the Action Alternative*

Because the odorous emissions from the Action Alternative are equivalent to or less than the odorous emissions of the Proposed Action, the addition of the grain-to-ethanol facility to the Action Alternative would result in small cumulative impacts compared with those of the Proposed Action with the grain-to-ethanol facility. Accordingly, DOE concludes that odors from the Action Alternative with the grain-to-ethanol facility would not be detectable offsite and would not result in any adverse cumulative impacts.

5.2.8 SOCIOECONOMICS

5.2.8.1 Grain-to-Ethanol Construction Relative to the Proposed Action

The construction of a grain-to-ethanol facility, which would occur while the biorefinery is operational, would result in cumulative impacts to socioeconomic variables including population and housing, employment and income, education, and public services. The impact would be small, less than 1 percent of the population baseline prior to the Proposed Action and less than 1 percent over the adjusted baselines (adjusted for operations under the Proposed Action).

DOE estimates that the maximum number of full-time construction workers for the grain-to-ethanol facility would increase by 148 persons for a short period (approximately 3 months). Fewer workers would be required during the balance of the construction phase. Therefore, the 3-month period with the highest employment of construction workers bounds the analysis. There also would be approximately 28 operations workers for the biorefinery employed during the same 3-month period of peak construction activity.

The cumulative impacts analysis, therefore, assumes a baseline population that incorporates expected change in population that would have occurred as a result of the Proposed Action change in population. The original baseline population (51,240 persons) would increase by 35 persons as a result of the operation of the biorefinery, for an adjusted population baseline of 51,275 persons. The grain-to-ethanol facility construction would result in a temporary population increase of 342 persons. Sixty-eight in-migrating people would be school-aged children. The increase in population resulting from the grain-to-ethanol facility construction would represent 0.67 percent of the 2007 baseline population and 0.66 percent of the population base adjusted for the Proposed Action biorefinery operations. The cumulative effect of the construction of the grain-to-ethanol facility while the biorefinery was operating (377 persons) would be 0.74 percent of the 2007 baseline population. Thus, the cumulative effect of the increased population from the operation of the biorefinery and the construction of the grain-to-ethanol facility on socioeconomic variables (housing, employment and income, education, and public services) would be small.

5.2.8.2 Grain-to-Ethanol Operations Relative to the Proposed Action

The operation of a grain-to-ethanol facility would result in cumulative impacts to socioeconomic variables because of an increase in the number of workers compared with the Proposed Action. DOE estimates that an additional 73 operations workers would be involved in grain-to-ethanol production. DOE estimates an increase in the population of 59 persons. School-aged children would represent approximately 15 members of the increased population. The increase in population represents about 0.12 percent of the 2007 baseline population and 0.12 percent of the population base adjusted for the operations of under the Proposed Action. The cumulative effect of the operation of the grain-to-ethanol facility while the biorefinery was operating (94 persons) would be 0.18 percent of 2007 baseline population. Thus, the cumulative impact to socioeconomic variables would be very small.

5.2.8.3 Grain-to-Ethanol Construction Relative to the Action Alternative

The construction of a grain-to-ethanol facility would result in cumulative impacts to socioeconomic variables including population and housing, employment and income, education, and public services. The impacts would be very small, less than 0.5 percent over the adjusted baseline (adjusted for the operation of the biorefinery under the Action Alternative).

DOE estimates that the maximum number of full-time construction workers would increase by 148 persons for a short period (approximately 3 months). Fewer workers would be required during the balance of the construction period of the grain-to-ethanol facility. Therefore, the 3-month period with the highest employment of construction workers bounds the analysis. There also would be approximately 28 operations workers for the biorefinery during the same 3-month period of peak construction activity.

This cumulative impact analysis assumes an adjusted baseline (adjusted to reflect the Action Alternative-induced changes in population) to determine the magnitude of impacts. The original baseline population (51,240 persons) would increase by 28 persons because of biorefinery operations under the Action Alternative, resulting in an adjusted population baseline of 51,268 persons. The grain-to-ethanol facility construction would result in a temporary increase of population of 342 persons. Sixty-eight in-migrating people would be school-aged children. The increase in population resulting from the grain-to-ethanol facility construction would represent 0.67 percent of the 2007 baseline population and 0.66 percent of the population base adjusted for the Action Alternative biorefinery operations. The cumulative effect of the construction of the grain-to-ethanol facility while the Action Alternative biorefinery was operating (370 persons) would be 0.72 percent of the 2007 baseline population. The cumulative effect of the increased population from the operation of the biorefinery and the construction of the grain-to-ethanol facility on socioeconomic variables (housing, employment and income, education, and public services) would be small. Most in-migrating workers and their families would be expected to leave the region when the construction assignment was completed.

5.2.8.4 Grain-to-Ethanol Operations Relative to the Action Alternative

The operation of a grain-to-ethanol facility would result in cumulative impacts to socioeconomic variables because of an increase in the number of workers compared with the biorefinery under the Action Alternative. DOE estimates that an additional 73 operations workers would be involved in grain-to-ethanol production compared with biorefinery operations under the Action Alternative. DOE estimates an increased population of 59 persons as a result of operations of the grain-to-ethanol facility. School-aged children would represent approximately 15 members of the increased population. The increase in population resulting from the grain-to-ethanol facility operations represents about 0.12 percent of the 2007 baseline population and 0.12 percent of the population base adjusted for the Action Alternative population baseline. The cumulative effect on population of the operation of the grain-to-ethanol facility while the biorefinery was operating under the Action Alternative (87 persons) would be 0.17 percent of the 2007 baseline population. Thus, the cumulative impact to socioeconomic variables would be very small, less than a 0.5-percent increase over baseline.

5.2.9 HEALTH AND SAFETY

5.2.9.1 Grain-to-Ethanol Facility Construction Relative to the Proposed Action

Construction of a grain-to-ethanol facility would occur while the biorefinery (Proposed Action) is operational. Therefore, the *industrial health and safety* impacts from construction of a grain-to-ethanol facility would occur in addition to the health and safety impacts from operation of the biorefinery under the Proposed Action. DOE estimates that the maximum number of full-time construction personnel during construction of the grain-to-ethanol facility would be 148 workers during the peak week of construction. This would be in addition to the estimated 43 workers required for operation of the biorefinery. The number of calculated full-time equivalent workers for construction, based on 2,000 hours per year per worker and the estimated number of workers per week, would be about 130 workers. Using the more conservative assumption of 148 workers, DOE estimates that about 8.0 additional *total recordable cases* (recordable cases include *days away from work*, *days of restricted work activity or job transfer*, and worker fatalities), about 4.1 additional days away from work, and about 0.015 additional fatality would occur because of construction of the grain-to-ethanol facility. These are in addition to the 2.7 total recordable cases, 0.94 days away from work, and 0.0014 fatality estimated to occur annually during operation of the biorefinery.

5.2.9.2 Grain-to-Ethanol Operations Relative to the Proposed Action

The addition of the grain-to-ethanol facility to the biorefinery would result in an increase in industrial health and safety impacts because of the increase in the number of workers relative to the biorefinery under the Proposed Action. DOE estimates that about an additional 73 workers would be involved in ethanol production, and an additional 1.25 workers would be involved in milling and grinding operations compared with the 43 total workers required for the Proposed Action. Based on the additional number of workers, DOE estimates that about 5.0 additional total recordable cases, about 1.4 additional days away from work, and about 0.0017 additional fatality would occur during operation of the grain-to-ethanol facility. These are in addition to the 2.7 total recordable cases, 0.94 days away from work, and 0.0014 fatality estimated to occur annually during operation of the biorefinery.

5.2.9.3 Grain-to-Ethanol Construction Relative to the Action Alternative

Construction of a grain-to-ethanol facility would occur while the biorefinery (Action Alternative) is operational, and therefore, the industrial health and safety impacts from construction of a grain-to-ethanol facility would occur in addition to the health and safety impacts resulting from operation of the biorefinery. The additional impacts from construction of the grain-to-ethanol facility would be the same as the impacts described relative to the Proposed Action because the facility being constructed, and thus the number of construction workers, would be the same. DOE estimates that the maximum number of full-time construction personnel would be 148 workers during the peak week of construction. This would be in addition to the estimated 34 total workers required for operation of the biorefinery. DOE estimates that about 8.0 additional total recordable cases, about 4.1 additional days away from work, and about 0.015 additional fatality would occur during the construction phase due to construction of the grain-to-ethanol facility. These are in addition to the 2.3 total recordable cases, 0.68 days away from work, and 0.0011 fatality estimated to occur annually during operation of the biorefinery (without the capability to produce excess electricity).

5.2.9.4 Grain-to-Ethanol Operations Relative to the Action Alternative

The operation of the grain-to-ethanol facility would result in an increase in industrial health and safety impacts because of an increase in the number of workers compared with the Action Alternative. The additional impacts from operation of the grain-to-ethanol facility would be the same as the impacts described relative to the Proposed Action because the facility being operated, and thus the number of workers required, would be the same. DOE estimates that about an additional 73 workers would be involved in ethanol production, and an additional 1.25 workers would be involved in milling and grinding operations, compared with the 34 total workers required for the Action Alternative. Using these assumptions, DOE estimates that about 5.0 additional total recordable cases, about 1.4 additional days away from work, and about 0.0017 additional fatality would occur during operations due to the grain-to-ethanol facility. These are in addition to the 2.3 total recordable cases, 0.68 days away from work, and 0.0011 fatality estimated to occur annually during operation of the biorefinery (without the capability to produce excess electricity).

5.2.10 ACCIDENTS

This section provides an analysis of the additional accident impacts for the grain-to-ethanol facility compared with the Proposed Action and Action Alternative.

5.2.10.1 Grain-to-Ethanol Facility Accidents Relative to the Proposed Action

The addition of the grain-to-ethanol facility would result in an increase in potential accident impacts because the inventory of toxic chemicals would increase, as would the size, number, and location of the toxic storage tanks (Roach 2009q). The increase in the toxic chemical inventory involves only one additional toxic chemical (phosphoric acid) (Roach 2009p). The impacts of the addition of phosphoric acid to the inventory and the impacts of the increase in number, size, and location of the tanks containing toxic chemicals are considered separately in the following sections.

5.2.10.1.1 *Phosphoric Acid*

For the grain-to-ethanol facility, phosphoric acid would be stored at the site in a 9,800-gallon (37-cubic-meter) tank and would be used in the ethanol production process (Roach 2009q). Phosphoric acid is a common inorganic acid used in fertilizers, waxes, soaps, and detergents, and is added to foods as a preservative, acidifying agent, and flavor enhancer (OEHHA 2009). It has *a protective action criteria level* 2 value of 50 milligram per cubic meter (ILO 2000), indicating moderate toxicity. It is not combustible and a harmful contamination of the air would not, or would only very slowly, be reached on evaporation at 20 degrees Celsius (68 degrees Fahrenheit) (ILO 2000). Therefore, failure of the phosphoric acid storage tank would not be expected to result in vapor buildup that would be harmful to offsite members of the public. For workers, exposure to vapors could result in a burning sensation, coughing, shortness of breath, and sore throat (ILO 2000). It is possible that an explosion near the tank could result in release of phosphoric acid vapors. However, the tank is not located near other facility operations where explosions would be likely to occur (Roach 2009p). Therefore, DOE concludes that failure of the phosphoric acid storage tank and subsequent release of phosphoric acid vapors would not result in any lasting health effects to workers or members of the public.

5.2.10.1.2 *Ethanol Storage Tanks*

For the Proposed Action, the ethanol storage tanks represent the largest target area for external events and bounds the target area for all toxic chemicals (Chapter 4, Section 4.12). This conclusion is also valid for the addition of the grain-to-ethanol facility since the addition of 6 more ethanol tanks represents a substantial increase in the ethanol storage tank area, significantly greater than for any other chemical (Roach 2009q). Table 5-22 shows the number, capacity, and dimensions of the ethanol tanks for the Proposed Action and for the grain-to-ethanol facility (Roach 2009r).

Table 5-22. Number, capacity, and dimensions of ethanol tanks for the Proposed Action and grain-to-ethanol facility.

Tank Type	Capacity [gallons (cubic meters)]	Dimensions: Diameter [feet (meters)]	Dimensions: Height [feet (meters)]	Number of tanks: Proposed Action	Number of tanks: Grain-to-ethanol
Storage	460,000 (1,700)	45 (14)	39 (12)	1	1
	1,000,000 (380)	60 (18)	48 (15)	0	3
Product Shift	60,000 (230)	20 (6.1)	26 (8)	2	2
	150,000 (570)	25 (8)	41 (12)	0	2
Off-specification	60,000 (230)	20 (6.1)	26 (8)	1	1
	150,000 (570)	25 (8)	41 (12)	0	1

Source: Roach 2009q.

As for the Proposed Action, DOE calculated the aircraft, meteor, and tornado ethanol tank strike probabilities for the grain-to-ethanol facility, accounting for the increase in size and number of ethanol tanks, as described in Table 5-22. The analytical methods for computing the strike probabilities were the same as those in Chapter 4, Section 4.12.1.1.1 using the revised ethanol tank characteristics. DOE also considered an adjustment to the number of aircraft flights at the Hugoton airport based on the anticipated increase in population in the region of influence due to biorefinery employees and family members. For the grain-to-ethanol facility, the anticipated population increase in the region of influence is 237 persons (Section 5.2.8.2). Since the region of influence population is estimated to be more than 60,000 people during facility operations (Chapter 3, Table 3-22), the projected population increase would represent an insignificant increase in the aircraft activity at Hugoton airport, and therefore not a significant increase in the ethanol tank aircraft strike probability.

Table 5-23 shows the results of the strike probabilities for the grain-to-ethanol facility. The results show only a modest increase in the ethanol tank strike probability for each external hazard. In all cases, the probabilities are well below the estimated tank failure probability from internal events of 8.8×10^{-4} per year (Chapter 4, Section 4.12.1.1.1, Table 4-52). Therefore, DOE concludes the change in size and number of ethanol tanks would not result in a meaningful increase in accident impacts to either workers or the public when compared with the Proposed Action.

Table 5-23. Ethanol tank strike probability for the Proposed Action and grain-to-ethanol facility.

Alternative	Ethanol tank strike probability (per year): Aircraft	Meteor	Tornado
Proposed Action[a]	5.6×10^{-6}	$< 2.0 \times 10^{-9}$	2.3×10^{-8}
Grain-to-ethanol facility	1.8×10^{-5}	$< 2.0 \times 10^{-9}$	1.4×10^{-7}

a. From Chapter 4, Section 4.12 of this EIS.

5.3 Cumulative Impacts from Other Future Actions

This section describes the potential incremental impacts (relative to the Proposed Action, Action Alternative, and grain-to-ethanol facility) from the addition of other reasonably foreseeable future actions; specifically, the truck bypass, the Nexsun Ethanol and Biodiesel Facility (Nexsun facility), and the Tallgrass Transmission, LLC project (Tallgrass Transmission project).

5.3.1 LAND USE

Incremental impacts from construction of the above-referenced foreseeable future actions on land use are expected to be small. Infrastructure-construction-related impacts would be confined generally to existing transportation and utility corridors. The Tallgrass Transmission project would likely be constructed across agricultural land, but the amount of land taken *out of production* is expected to be limited to construction of the towers that support the transmission lines and substations. Since approximately 97 percent of the land within the region of influence is in farms, construction of the Transmission project would have a negligible impact on land use. Land use between the towers and beneath the transmission lines would largely remain unaffected. Construction of the Nexsun facility would be expected to impact land use similarly to construction of the Abengoa biorefinery, which would be small. Therefore, DOE anticipates the incremental impact of construction of these projects would be small.

Incremental impacts from operation of the infrastructure component of the above-referenced projects on land use are expected to be small. Once constructed, operation of infrastructure would be expected to have a negligible impact on land use. However, as discussed below, operation of the Nexsun facility would be expected to have an incremental impact on land use due to the increased demand for grain feedstock.

Since the Nexsun facility annual ethanol production would be about half that of the Abengoa Biorefinery grain-to-ethanol facility, the grain feedstock demand is also expected to be half. Based on this assumption, the amount of grain consumed by grain-to-ethanol facilities within the region of influence would increase from 31 million bushels (790,000 metric tons) to 46.5 million bushels (1.2 million metric tons). Locally grown milo and corn would be procured as the grains of choice for the Nexsun facility. The incremental impact of increased demand for corn is not anticipated to have a noticeable impact on land use because the amount of corn produced within the region of influence significantly exceeds the cumulative incremental demand. Further, the Nexsun facility would be expected to have a region of influence that overlaps, but is separate from, the Abengoa Biorefinery Project region of influence. Therefore, there is no apparent incentive to alter land use for the purpose of meeting the grain-to-ethanol facilities’ demand for corn.

The incremental impact of increased demand for grain sorghum is expected to increase the amount of grain sorghum produced within the region of influence. As previously described, the Abengoa Biorefinery grain-to-ethanol facility anticipated grain sorghum consumption is expected to be greater then the amount produced within the region of influence. The Nexsun facility increases the apparent supply versus demand discrepancy. If local grains within the Abengoa Biorefinery Project region of influence were the only feedstock source, the demand for grain sorghum could result in changes in land use type. However, as described above, the Nexsun facility would be expected to have a separate, although overlapping, region of influence and thereby reduce the incremental impact within the Abengoa Biorefinery Project region of influence. Also, because these grain commodities have established distribution systems, local supply is not the only feedstock source. This is apparent when considering the Abengoa Biorefinery grain-to-ethanol facility would utilize 7 million bushels (180,000 metric tons) of corn from outside the region of influence compared with 2.7 million bushels (70,000 metric tons) from local sources even though the local source is approximately 100 million bushels (2.5 million metric tons).

The capability for both facilities to interchangeably utilize corn and grain sorghum and the existing distribution systems that can be utilized to supplement feedstock shortages provide feedstock procurement flexibility and reduce the likelihood that land use type would be altered in order to meet demand. As discussed in Chapter 4, Section 4.1.1.1.1, the nationwide reduction in CRP acreage also reduces the likelihood that the incremental impact would result in changes in land use type. CRP land eliminated from the Program would be available for crop production. Crop production on former CRP acreage would be a change in land use type, but this land use change would be induced by Program rules, not the incremental impact of increased demand for grain sorghum. Based on these considerations, the shortage of grain sorghum in relation to total cropland within the region of influence, and the general land use change model, DOE anticipates the increase in grain sorghum production would likely come from increased production on existing cropland.

5.3.2 AIR QUALITY

Construction of the truck bypass would cause temporary emissions from various activities including the use of heavy diesel-operated equipment, disturbance of the soil, grading activities, material transport, and material handling. Construction of the truck bypass and construction of the biorefinery under the Proposed Action and Action Alternative may occur simultaneously. Thus the emissions from both construction projects would contribute to cumulative impacts to air quality; however, these impacts would be temporary in nature. Further, due to the spatial separation of the projects and dispersion of air pollutants relative to time and distance, the cumulative effects would be small.

The Nexsun facility would produce an estimated 44 million gallons (170 million liters) per year of ethanol and 3 million gallons (11 million liters) per year of biodiesel. An emission summary of the Nexsun facility was not available for review. However, the amount of ethanol that would be produced by the Nexsun facility is approximately 50 percent of the ethanol that would be produced by the grain-to-ethanol facility described in Section 5.1.2.1. Therefore, emissions from the Nexsun facility were estimated by scaling the emissions of the grain-to-ethanol facility by 50 percent. Table 5-24 shows a summary of the incremental emission estimate of the Nexsun facility compared with the Proposed Action, Action Alternative, and the grain-to-ethanol facility. The estimated emissions from the Nexsun facility are less than the individual emissions from the Proposed Action, Action Alternative, and grain-to-ethanol facility. Because the air quality impacts from the Proposed Action with grain-to-ethanol facility (highest air pollutant concentrations) would be much less than the National Ambient Air Quality Standards, then it can be assumed that the Nexsun facility also would be below the standards. Further, the projects are separated by approximately 28 miles (45 kilometers), and the maximum modeled concentration for all pollutants and averaging times under the Proposed Action is approximately 300 feet (100 meters) north of the biorefinery fence line. Due to this spatial separation of the projects (about 28 miles) and dispersion of air pollutants relative to time and distance, the cumulative effects would be very small.

Table 5-24. Estimated emissions of the Nexsun Facility in comparison with the biorefinery under the Proposed Action, Action Alternative, and grain-to-ethanol facility.

Pollutant	Proposed Action controlled emissions		Action Alternative controlled emissions		Grain-to-ethanol facility controlled emissions		Nexsun facility estimated controlled emissions	
	Tons per year[a]	Metric tons per year	Tons per year[a]	Metric tons per year	Tons per year[a]	Metric tons per year	Tons per year	Metric tons per year
Particulate matter	232.88	211.26	31.74	28.79	59.80	54.25	29.90	27.12
PM_{10}	215.13	195.16	25.88	23.48	52.23	47.38	26.12	23.69
$PM_{2.5}$	205.68	186.59	23.73	21.53	49.02	44.47	24.51	22.23
Nitrogen oxides	993.21	901.02	313.92	284.78	79.78	72.37	39.89	36.19
Sulfur dioxide	166.06	150.65	46.50	42.18	1.15	1.04	0.58	0.52
Carbon monoxide	1,065.54	966.64	216.78	196.66	92.09	83.54	46.05	41.77
Volatile organic compounds	157.45	142.84	58.27	52.86	131.74	119.51	65.87	59.76
Total hazardous air pollutants	32.37	29.37	7.81	7.09	11.75	10.66	5.88	5.33

a. Source: Roach 2009c.
PM_{10} = particulate matter with an aerodynamic diameter less than or equal to 10 micrometers.
$PM_{2.5}$ = particulate matter with an aerodynamic diameter less than or equal to 2.5 micrometers.

As with the truck bypass, the main source of emissions from construction of the Tallgrass Transmission project would be from the use of diesel equipment, disturbance of the soil, grading activities, material transport, and material handling. These emissions would only be expected to occur during the construction phase of the project. Based on preliminary information on the scheduled construction of the Tallgrass Transmission project (provided in Section 5.1.2.4 above), construction activities would likely occur during both the construction and operations phases of the Proposed Action or Action Alternative. However, because of the distance between the Tallgrass Transmission project and the biorefinery under the Proposed Action or Action Alternative [about 30 miles (48 kilometers)], the construction-related emissions from the transmission line would likely not cause any adverse cumulative impacts to the air quality.

5.3.3 HYDROLOGY

5.3.3.1 Surface Water

Construction of the truck bypass could have surface water impacts, though minor, that would be cumulative with those associated with the biorefinery (Proposed Action and Action Alternative) and grain-to-ethanol facility. Neither the Nexsun facility nor the Tallgrass Transmission project would involve cumulative impacts related to surface water with respect to the biorefinery and grain-to-ethanol facility. Drainage in the vicinity of the Biorefinery Project site is internal and to multiple low playa areas. The Nexsun and Tallgrass projects are too far removed [more than 28 miles (45 kilometers)] to have any effects on these low areas. Specifically, there would be no common drainage areas for these three reasonably foreseeable future actions.

The truck bypass would be expected to result in small changes to runoff, and since portions of the new road would be adjacent to the Biorefinery Project site, changes resulting from both actions could be cumulative. For the most part, the new bypass would be constructed over existing roadways, so once the road construction was complete, runoff from most areas would not be much different than from existing conditions. The more meaningful change in runoff, however, would be expected to be in the locations of curves where the road would be constructed over new area to avoid 90-degree turns. The sections of new and modified road would be expected to have roadside ditches as necessary to control runoff and would represent relatively minor changes in surface drainage. Next to the biorefinery parcel, the bypass road likely would involve minor amounts of additional runoff during precipitation events, but this additional water would not adversely impact the runoff management features planned for the biorefinery. The truck bypass would not involve any additional potential for releases of contaminants that could reach surface water.

5.3.3.2 Groundwater

Potential cumulative impacts to groundwater relative to the Proposed Action and Action Alternative and the truck bypass, Nexsun facility, and the Tallgrass Transmission project are possible, but are likely to be small. Construction water use for dust suppression and soil compaction would occur for all three foreseeable future actions within the region of influence, but only the Nexsun facility would have continued water use for process use over time. The quantity of water that would be required for construction of the future actions is unknown but would be expected to be commensurate with the standard construction water use patterns associated and described for the Proposed Action and Action Alternative, including dust suppression, soil compaction, and incidental construction water use. The construction of the truck bypass is the only future action that would occur in proximity to the Proposed Action and Action Alternative, as the Nexsun facility would be approximately 28 miles (45 kilometers) from the Biorefinery Project site, and the Tallgrass Transmission project would be in the southern extreme of the region of influence, more than 30 miles (48 kilometers) from the Project site. The source for the water supply for construction of the truck bypass is unknown but is assumed to be provided by the City of Hugoton or by existing Stevens County water supply wells. The water source for the Tallgrass Transmission project also is unknown but would be expected to be from existing water supply systems close to the project area, such as the City of Guymon, Oklahoma. The source of water for the Nexsun facility would be the City of Ulysses. The groundwater source for the future actions, even if supply is obtained from existing entities, would be primarily the High Plains aquifer. While the groundwater source may be the same *aquifer*, the distance between the Tallgrass Transmission project and the Nexsun facility would preclude direct, interrelated incremental impacts. Construction water use for the truck bypass would be from the same general area as the biorefinery; construction water use, however, would be expected to be of short duration for all three future actions and would not be likely to have meaningful cumulative impacts to groundwater.

The Nexsun facility would require a continuous water supply for operations. The quantity of water to be used for operation of the Nexsun facility is unknown, but would be expected to be substantially greater than the volume used for its construction. The source for groundwater in Ulysses is expected to be the High Plains aquifer, but the area is also underlain by the Dakota and Morrison-Dockum aquifers, which may be use in addition to the High Plains aquifer. Chapter 3, Section 3.4.2 describes the *affected environment* of the region of influence and includes the area of the Nexsun facility. Public water supply wells for the City of Ulysses would be located within or in close proximity to the city.

Operation of the Ulysses wells and volumes produced would be expected to increase when supplying water to the Nexsun facility, but would not have a direct effect on groundwater quantity in the vicinity of Hugoton. Groundwater withdrawals near Ulysses for the additional volume to supply the Nexsun facility would not be expected to interfere with or impact the volume of water near Hugoton, nor would the effects of pumping extend between the two localities. While there would appear to more use and withdrawal of groundwater from the common resource with the Nexsun facility and the biorefinery, both during construction and operations, each is independently subject to Kansas water appropriation regulations designed to manage the depletion of the High Plains aquifer and to preclude impairment of existing water rights. It is unknown whether the City of Ulysses needed to acquire additional water rights to supply the Nexsun facility. Adverse cumulative impacts to groundwater relative to the Proposed Action or Action Alternative are not expected for the operation of the Nexsun facility.

Considering that the Nexsun facility would provide an additional outlet for grain within the region of influence, incremental changes in cropping practices and potential irrigation use may occur. While the Nexsun facility location would be within the region of influence for grain and biomass procurement, only the grain demand would overlap. As noted through analysis for the Proposed Action, Action Alternative, and the grain-to-ethanol facility, significant changes to cropping patterns would not be expected by these actions alone. With increased demand for grain within the region of influence, some minor changes in cropping practices might be observed to accommodate an increase in grain sorghum production (there appears to be ample corn produced for feedstock demand within the region of influence). However, based on the analysis for land use presented in Chapter 4, Section 4.1 and Section 5.2.1 above, adverse cumulative impacts related to changes in cropping practices through conversion of non-cropland to cropland or management of existing cropping patterns would not be expected, and the rationale appears applicable to further increase in grain demand within the region of influence. Associated increases in groundwater use associated with cropping practices also are expected to be small, and water appropriation regulations would come into play to limit increased irrigation and thus, incremental effect on groundwater.

5.3.4 UTILITIES, ENERGY, AND MATERIALS

None of the other identified potential future actions would be expected to have any effect on the water, sewer, or solid waste services of Hugoton, but there could be some cumulative effects on energy and material sources. Cumulative effects on natural gas, electricity, and other energy demands are addressed in the following paragraphs, along with impacts from similar construction material needs.

5.3.4.1 Electricity

Under the Action Alternative, the biorefinery would produce about 11.4 million gallons (43,000 cubic meters) of ethanol per year and require an average electrical demand of about 10 megawatts from the regional grid, plus another 20 megawatts supplied by an internal generator. Based on the Nexsun facility biorefinery production capacity of 44 million gallons (170 cubic meters) of ethanol per year, it is assumed that the facility would have an average electric demand of about 120 megawatts. These values are very minor in comparison with the average summer demand of 41,000 megawatts within the entire Southwest Power Pool. Further, under the Proposed Action and the reasonably foreseeable grain-to-ethanol facility considered in Section 5.2.4, the biorefinery and grain-to-ethanol facility would have an electrical co-generation capability of about 60 megawatts, so the two actions (Proposed Action with the grain-to-ethanol facility and the Nexsun facility) would have somewhat offsetting electrical demands on the regional electrical grid.

Neither the truck bypass nor the Tallgrass transmission projects would be expected to involve any significant demand for electricity. However, the purpose for the Tallgrass project would be to connect a source of additional electrical power to the Southwest Power Pool grid. This source of additional power would help offset any demand represented by the other actions.

5.3.4.2 Natural Gas

The Nexsun facility's annual production of 44 million gallons (170 cubic meters) of ethanol can also be compared with the 88 million gallons (330,000 cubic meters) that would be produced by the grain-to-ethanol facility. As noted in Section 5.2.4, the biorefinery (Proposed Action) and the grain-to-ethanol facility would require about 4 million cubic feet (110,000 cubic meters) of natural gas per day; however, on an annual basis, this would be only 0.39 percent of the amount of natural gas produced and sold in Kansas in 2007. Based on their relative production capacities, it is expected that the Nexsun facility requirement for natural gas would be no more than about half of that identified under the combined Proposed Action and grain-to-ethanol facility. The natural gas demands for the Nexsun facility, the biorefinery, and grain-to-ethanol facility would be cumulative, but would be a very small portion (on the order of 0.6 percent) of the quantity of natural gas produced and sold within Kansas.

5.3.4.3 Other Fossil Fuels and Petroleum Products

Estimates for the amount of diesel that would be used by the biorefinery were the same for the Proposed Action [producing about 18 million gallons (68,000 cubic meters) of ethanol per year] and with the grain-to-ethanol facility [producing about 88 million gallons (330,000 cubic meters) of ethanol per year]. Both actions were estimated to require about 1.8 million gallons (6,800 cubic meters) of diesel fuel per year. If it is assumed that the Nexsun facility required a similar amount of diesel fuel, then the cumulative demand would be about 3.6 million gallons (14,000 cubic meters) per year, although this would be offset somewhat, as the Nexsun facility also would produce an estimated 3 million gallons (11,000 cubic meters) per year of biodiesel.

Both the truck bypass and the Tallgrass Transmission project would require fuel during construction, but these requirements would be relatively short term in nature and would not be expected to be significant in comparison with the combined annual requirements of the biorefinery, grain-to-ethanol facility, and the Nexsun facility. The cumulative demand of about 3.6 million gallons (14,000 cubic meters) per year would be a small portion (about 0.1 percent) of the Kansas annual petroleum product consumption rate of about 3,500 million gallons (13.2 million cubic meters) and would not be expected to adversely impact the availability of petroleum products.

5.3.4.4 Materials

The three reasonably foreseeable future actions (the truck bypass, the Nexsun facility, and the Tallgrass Transmission project) would require construction materials that would be cumulative to some extent with the construction materials that would be required for the biorefinery and grain-to-ethanol facility. Construction of the bypass would require fill material and asphalt, both of which would be required for the biorefinery and grain-to-ethanol facility. The Tallgrass Transmission project would require power poles and high-power electrical lines, both of which would be required for the biorefinery (Proposed Action and Action Alternative). However, the Nexsun facility would have the most significant cumulative effect because it would be expected to require essentially all of the same construction materials as the biorefinery and grain-to-ethanol facility. With the possible exception of fill materials, it is expected that construction materials for all of these potential actions would be from regional or national markets. As identified in Chapter 4, Section 4.5 and above in Section 5.2.4, the only construction material believed to represent possible availability issues would be stainless steel, and only the Nexsun facility (among the foreseeable future actions) would be expected to involve relatively significant quantities of this material.

Based on their relative production capacities, the amount of steel and stainless steel that would be required by the Nexsun facility likely would be somewhere between the amounts identified for the biorefinery under the Proposed Action and for the combined Proposed Action and grain-to-ethanol facility. If it were conservatively assumed that the Nexsun facility required the same quantities as the larger biorefinery and grain-to-ethanol facility, then there would be a cumulative need for about 23,000 tons (21,000 metric tons) of steel, of which about 13,000 tons (12,000 metric tons) would be stainless steel. The combined 23,000 tons of steel would still be very small in comparison with the U.S. steel production of about 107 million tons (97 million metric tons) in 2007 (USGS 2008). Further, if the combined 13,000 tons of stainless steel required 10 percent of that material to be nickel, then the 1,300 tons (1,200 metric tons) of nickel would be small in comparison with the 269,000 tons (244,000 metric tons) of nickel that were either imported or recovered from scrap in the U.S. in 2007. Although there could be availability issues associated with the cumulative demand for stainless steel, the amounts required would be minor in comparison with the amount that is moved through the U.S. market each year, and thus cumulative impacts would be minor. In addition, the preceding evaluation addressed a combined demand for stainless steel and conservatively compared those values with annual market quantities. However, the separate demands would not all occur in the same year.

5.3.5 WASTES, BYPRODUCTS, AND HAZARDOUS MATERIALS

Construction of the truck bypass would involve improving the existing asphalt road base and adding an additional asphalt layer to support anticipated truck and vehicular traffic (Figure 5-2). This process would involve milling the existing asphalt, thereby reducing the existing asphalt thickness by a certain degree (prior to adding the new layer). The actual construction specifications do not yet exist. The milling would produce milled asphalt as a waste. Milled asphalt is typically stockpiled by transportation departments and asphalt producers and recycled in the production of new asphalt. Therefore, the milled asphalt is not anticipated to be disposed of as a solid waste. No other significant waste streams or use of hazardous materials would be anticipated relevant to the construction of the truck bypass.

Wastes generated and hazardous materials used during construction and operation of the Tallgrass Transmission Project would be anticipated to be minimal. Organic waste (for example, trees, shrubs, and vegetation) generated from land clearing would be mulched or burned. Minor amounts of solid waste, such as construction materials, packaging, and inorganic municipal solid waste, would be disposed of at permitted landfills closest to the construction site.

Potentially significant waste streams or use of hazardous materials would not be anticipated for the truck bypass or Tallgrass Transmission project. Most of the wastes and hazardous materials impacts anticipated due to the three reasonably foreseeable future actions would be associated with the construction and operation of the Nexsun facility. Therefore, DOE focused its analysis on the potential incremental impacts of the Nexsun facility.

5.3.5.1 Construction Related

The Nexsun facility would produce an estimated 44 million gallons (167,000 cubic meters) per year of ethanol and 3 million gallons (11,000 cubic meters) per year of biodiesel. Construction and operations details were not available for review. It is anticipated, however, that this facility would generate approximately one-half the construction- and operations-related wastes estimated for the grain-to-ethanol facility, which would produce 88 million gallons (333,000 cubic meters) per year of ethanol. Table 5-25 lists the estimated construction-related wastes associated with the addition of the three future actions, including the Nexsun facility, relative to the Proposed Action, Action Alternative, and grain-to-ethanol facility.

Table 5-25. Construction-related wastes.

	Quantity/Volume			
Type of Waste	Proposed Action [tons (metric tons)]	Action Alternative [tons (metric tons)]	Grain-to-ethanol increment [tons (metric tons)]	Other future actions increment [tons (metric tons)]
Ground excess, construction and demolition debris	34,800 (31,600)	31,350 (28,440)	17,945 (16,279)	9,000 (8,200)
Plastics, papers, and cartons	7 (6.4)	6 (5.4)	3 (2.7)	1.5 (1.4)
Steel waste, pipes, and cables (trimmings and wastes)	66 (60)	59 (54)	34 (31)	17 (15)
Metal cans (painting, chemical, oil)	13 (12)	12 (11)	7 (6.4)	3.5 (3.2)
Municipal solids (inorganic)	89 (81)	80 (73)	46 (42)	23 (21)
Totals	35,008 (31,760)	31,507 (28,583)	18,035 (16,361)	9,045 (8,205)

Sources: Roach 2009e, 2009s.

The Nexsun facility construction wastes likely would be disposed of at the Grant County construction and demolition landfill. There are no permit conditions restricting the amount of waste received per day or per year at this facility. The construction wastes from the Proposed Action, Action Alternative, and grain-to-ethanol facility also likely would be disposed of at the Grant County construction and demolition landfill; the landfill has adequate capacity to receive the wastes (Chapter 3, Section 3.7). This landfill has 12 acres (0.049 square kilometer) permitted to receive construction and demolition wastes, and has the ability to expand its capacity through modification of its operating permit. Therefore, the cumulative adverse impact of the Proposed Action or Action Alternative with the grain-to-ethanol facility and other future actions is small.

5.3.5.2 Operations Related

Table 5-26 lists the estimated operations-related wastes associated with the three reasonably foreseeable future actions, including the Nexsun facility, relative to the Proposed Action or Action Alternative with the grain-to-ethanol facility.

Based on the discussion in Section 5.2.5.2, DOE concludes there would be adequate capacity of cattle feedlots to consume the additional distiller’s grains with solubles produced by the Nexsun facility. For this reason, there would be no adverse cumulative impact from the production of wet distiller’s grains from the combined Proposed Action and grain-to-ethanol facility and the Nexsun facility.

It is estimated that the Nexsun facility would generate additional municipal solid waste [29 tons (26 metric tons) per year] and hazardous waste [0.5 ton (454 kilograms) per year] relative to the Proposed Action and grain-to-ethanol facility. The municipal solid waste is likely to be transported to the Grant County solid waste transfer station. While the ultimate landfill destination is unknown, DOE concludes this relatively minor amount of waste is negligible and there would be no adverse cumulative impact from the solid waste streams from the combined Proposed Action and grain-to-ethanol facility and the three future actions.

DOE does not anticipate adverse impacts from the handling and disposal of the additional hazardous waste generated during operation of the Nexsun facility if the Kansas Department of Health and Environment regulations are met. The quantities of hazardous waste generated from the Proposed Action, grain-to-ethanol facility, and the three reasonably foreseeable future actions are considered negligible. There would be no adverse cumulative impact from hazardous waste generation from the Proposed Action, grain-to-ethanol facility, and the three future actions.

The Nexsun facility would generate municipal sewage and process wastewater. Sewage disposal could impact the Ulysses municipal wastewater treatment system. Land-application of treated or non-contact wastewater could impact land local to the Nexsun facility. The wastewater treatment facilities associated with the Nexsun facility are unknown. However, wastewater generated by the Nexsun facility would have no cumulative impact relative to the biorefinery under the Proposed Action and the grain-to-ethanol facility, as the facilities are more than 28 miles (45 kilometers) apart.

The Nexsun facility likely would use acids, caustics, ammonia, and other chemicals in the production process. As discussed in Section 5.2.5.2, based on the chemical requirements and the availability of supplies, chemicals would be imported from suppliers outside the 50-mile (80-kilometer) region of influence. DOE concludes the chemical needs of the Nexsun facility would have no adverse cumulative impacts on chemical users and suppliers within the region of influence. In addition, the annual demands for these chemicals by the Proposed Action, grain-to-ethanol facility, and Nexsun facility would be insignificant percentages of annual U.S. production quantities (Chapter 4, Section 4.6.1.4).

Table 5-26. Operations-related wastes.

Type of Waste	Annual quantity/volume			
	Proposed Action	Action Alternative	Grain-to-ethanol increment	Other future actions increment
Wet distiller's grain with solubles	0	0	782,000 tons (709,000 metric tons)	455,000 tons (413,000 metric tons)
Dry distiller's grain with solubles.	0	0	152,000 tons (138,000 metric tons)	0
Dirt and fines resulting from biomass processing	33,600 tons (30,500 metric tons)	8,750 tons (7,940 metric tons)	0	0
Municipal solid waste and construction debris	33 tons (30 metric tons)	26 tons (24 metric tons)	57 tons (52 metric tons)	29 tons (26 metric tons)
Wastewater treatment plant sludge	7.5-10 gallons (28.4-38 liters) per minute	5 to 7.5 gallons (19-28.4 liters) per minute	2.5-5 gallons (9.5-19 liters) per minute	Unknown
Hazardous waste	1 ton (0.9 metric ton)	1 ton (0.9 metric ton)	0.5 ton (0.45 metric ton)	0.5 ton (0.45 metric ton)
Distiller's residual biomass solids (stillage cake)	116,550 dry tons (105,730 metric tons)	45,000 dry tons (41,000 metric tons)	0	0
Lignin	44,709 tons (40,559 metric tons)	19,000 tons (17,000 metric tons)	0	0
Genetically modified organisms	Included in stillage cake and syrup	Included in stillage cake and syrup	0	0
Solid biomass boiler ash	79,671 tons (72,276 metric tons)	11,400 tons (10,300 metric tons)	0	0
Gasification ash	0	8,500 tons (7,700 metric tons)	0	0
Recycled process wastewater	250 gallons (950 liters) per minute	160 gallons (600 liters) per minute	700 gallons (2,600 liters) per minute	Unknown
Land-applied non-contact wastewater	225 gallons (852 liters) per minute	115 gallons (435 liters) per minute	235 gallons (890 liters) per minute	Unknown

Sources: Roach 2009e, 2009q.

5.3.6 TRANSPORTATION

Over the expected biorefinery 30-year operations phase, under the Proposed Action or Action Alternative, there would be an estimated 13,400 traffic fatalities in Kansas and 820 traffic fatalities in the nine counties surrounding the Biorefinery Project site. The three reasonably foreseeable future actions could result in increased traffic fatalities in these nine counties and in Kansas. During construction, these increases would be temporary and would be related to commuting construction workers and shipment of construction-related materials. During operations, these increases would be due to commuting operations workers and the shipment of operations-related materials. Traffic fatalities for the future actions have not been estimated. However, based on their descriptions in Sections 5.1.2.2, 5.1.2.3, and 5.1.2.4, it is anticipated that the additional traffic fatalities from these projects would be minimal in the nine counties surrounding the Project site and in Kansas. In addition, the truck bypass would reduce traffic congestion, and potential traffic accidents leading to transportation-related fatalities, in the City of Hugoton currently caused by truck traffic.

5.3.7 AESTHETICS

5.3.7.1 Visual Resources

Construction of the truck bypass would cause temporary visible emissions from various activities including disturbance of the soil and road grading. Construction of the truck bypass and construction of the biorefinery under the Proposed Action or Action Alternative may occur simultaneously. Thus, the visible emissions from both construction projects would cause cumulative visual impacts; however, these impacts would be temporary in nature. The truck bypass is intended to be complete by the time biorefinery operations commenced, whether under the Proposed Action or Action Alternative, thus there would be no cumulative visual impacts caused by construction of the truck bypass during the operations phase of the Proposed Action or Action Alternative.

Because of the distance between the Proposed Action or Action Alternative and the Nexsun facility [approximately 28 miles (45 kilometers)] and the Tallgrass Transmission project [approximately 30 miles (48 kilometers)], the construction and operation of these future actions would not be visible from the Biorefinery Project site and, therefore, would not cause adverse cumulative visual impacts.

5.3.7.2 Noise

Transportation-related noise associated with use of the truck bypass would be less than would occur under either the Proposed Action or Action Alternative, in that the bypass avoids more heavily populated areas (that is, noise from trucks would affect fewer people). It is expected that 50 percent of all truck traffic to and from the biorefinery and grain-to-ethanol facility during operations would use the truck bypass. The bypass would begin approximately 1 mile (1.6 kilometers) north of Hugoton, and trucks would travel along Road Q to Road 12 to access the facilities from Road P (Figure 5-2). The bypass would eliminate noise-related impacts to the residential area in the northwest corner of the city of Hugoton. However, two residences along Road Q would experience 220 truck passes per day between 7 a.m. and 9 p.m. This is the equivalent of an average of one truck approximately every 3.8 minutes. The typical noise level for trucks at highway speed [approximately 55 miles (89 kilometers) per hour] is approximately 90 dBA. Trucks on Road Q would likely be traveling at a lower speed after just turning off US-56, so lower noise levels would be typical, but would still be sufficient to interfere with outdoor conversations and cause annoyance indoors. Further, because the truck traffic would be almost constant, it would be more likely to be annoying.

Because the Nexsun facility and the Tallgrass Transmission project are not close enough geographically to cause noise impacts to the same receptors (for example, residents and hospitals) as the Proposed Action or Action Alternative, no cumulative noise impacts would occur.

5.3.7.3 Odor

Construction of the truck bypass would cause temporary odorous emissions from diesel construction equipment and newly lain asphalt. Although the truck bypass and the biorefinery under the Proposed Action or Action Alternative could undergo construction simultaneously, minimal temporary cumulative odor impacts near the sources are anticipated. The truck bypass is intended to be complete by the time the biorefinery is operational, thus there would be no cumulative impacts during the operations phase of the Proposed Action or Action Alternative relative to the truck bypass.

The biorefinery would not result in detectable offsite odors based on modeled concentrations compared with reference concentrations. As was estimated in Table 5-24, the Nexsun facility would emit amounts of volatile organic compounds and total hazardous air pollutants (sources of odors) that are less than or equivalent to those of the Proposed Action and Action Alternative. However, because the distance between the two facilities would be approximately 28 miles (45 kilometers), it is not possible for the odorous emissions from the two facilities to interact and cause adverse cumulative impacts.

The main source of odorous emissions from the Tallgrass Transmission Project would be from the use of diesel construction equipment; however, this would be temporary in nature. Based on preliminary information, the Tallgrass Transmission project likely would occur during both the construction and operations phases of the Proposed Action or Action Alternative. However, because of the distance between the location of the Proposed Action or Action Alternative and the Tallgrass Transmission project [approximately 30 miles (48 kilometers)], the construction of the transmission line would not cause any cumulative impacts from odorous emissions, as the odors from the two separate projects would dissipate without interacting.

5.3.8 SOCIOECONOMICS

Construction of the truck bypass is expected to be completed during operation of the biorefinery and during construction of the grain-to-ethanol facility. Because of the duration (few months) and nature of the truck bypass (principally grading and resurfacing of existing roads), DOE anticipates that its construction would not require additional workers beyond the available baseline. In addition, the Nexsun facility and Tallgrass Transmission project are a sufficient distance from the biorefinery and grain-to-ethanol facility such that there would be no cumulative impacts to socioeconomic variables, including population and housing, employment and income, education, and public services

5.3.9 HEALTH AND SAFETY

Construction and operation of the three reasonably foreseeable future actions would create the potential for injuries or fatalities to workers involved in those actions. However, the details of those projects are not yet sufficiently developed for the number of workers, and thus the estimated health and safety impacts, to be estimated.

5.3.10 ACCIDENTS

DOE anticipates that accident impacts from the Nexsum facility would be similar to those at the biorefinery and grain-to-ethanol facility. This is based on the assumption that the same chemicals would be stored in bulk at the Nexsum facility, in similar quantities, and the accident probabilities would be similar. Accidents from tornados and earthquakes would be similar since the facility is located in the same general region as the biorefinery. Accidents from aircraft crashes would also be similar or less since the Nexsum facility is not located near a busy airport. The accident impacts would thus be expected to include the potential for minor health effects for workers, with deaths possible under unusual circumstances, and no lasting health effects to members of the public.

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Chapter 6

Best Management Practices and Mitigation

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LIST OF TABLES

6. BEST MANAGEMENT PRACTICES AND MITIGATION

This chapter describes measures to *mitigate* adverse environmental impacts from the construction and operation of the *biorefinery* under either the *Proposed Action* or Action Alternative. The U.S. Department of Energy (DOE or Department) will consider these measures in deciding in its *Record of Decision* whether to provide federal funds for the design, construction, and startup of the biorefinery.

6.1 Best Management Practices

The measures comprise two categories: *best management practices* and mitigation measures. For the purposes of this Abengoa Biorefinery Project EIS, best management practices are defined as the practices, techniques and methods, and processes and activities commonly accepted and used throughout the construction and ethanol and energy production industries to facilitate compliance with applicable requirements, and that provide an effective and practicable means of avoiding or reducing the potential environmental impacts of the Proposed Action and Action Alternative (described in Chapter 4). Best management practices are integral to the design, construction, and operation of the biorefinery, and thus are incorporated into the description of the Proposed Action and Action Alternative (see Chapter 2). In general, best management practices include actions taken in compliance with other government agency regulations, stipulations, or guidance; coordination with other agencies and interested parties; implementation of Departmental policies and orders; implementation of industry practices and policies; and monitoring of relevant ongoing or future activities. Table 6-1 lists best management practices under consideration by DOE.

Table 6-1. Best management practices under consideration.

Land use
• Reclaim lands disturbed during the construction process. • Restore disturbed areas to their approximate condition before construction. • Abide by relevant zoning regulations. • Select non-irrigated, marginal land near a major road for biomass satellite storage locations. This would avoid taking highly productive land out of production. Targeted land would not include prime farmland or land enrolled in the Conservation Reserve Program. • Target feedstocks commonly available within the region of influence through biomass purchase contracts. • Target highly productive land with limited soil resource concerns. • Consult with public and private stakeholders to identify and develop alternative feedstocks suitable to growing conditions within the region of influence. • Harvest feedstock in accordance with Natural Resources Conservation Service guidelines to minimize soil erosion potential. • Harvest feedstock in a manner conducive to minimizing soil compaction and preserving soil integrity. • Make a nutrient replacement program available to the feedstock producer. The voluntary nutrient replacement program provides a method for feedstock producers to replace soil nutrients removed through feedstock harvesting. The voluntary program would not require feedstock producers to use Abengoa Bioenergy as their nutrient replacement source.

Table 6-1. Best management practices under consideration (continued).

Air quality
• Reduce fugitive dust emissions during construction using control measures such as water spraying, chemical treatment, and wind fences. • Reduce fugitive dust emissions during construction using control measures such as limiting activities in areas not being used for construction and the number of locations to access construction areas and staging construction activities to avoid simultaneous dust-generating activities. • Pave in-plant haul roads and post a maximum speed limit of 15 miles per hour (24 kilometers per hour) to control particulate matter, PM_{10}, and $PM_{2.5}$. Additional maintenance such as sweeping and watering the paved roads also would provide control for particulate matter. • Reduce particulate matter, PM_{10}, and $PM_{2.5}$ fugitive emissions from unpaved biomass laydown roads through the use of chemical stabilization and wind fences. • Reduce particulate matter, PM_{10}, and $PM_{2.5}$ emissions in the onsite biomass handling and milling systems, and from the sand and ash handling systems by using dust collectors (baghouses). • Increase capture efficiency of particulate matter, PM_{10}, and $PM_{2.5}$ emissions resulting from the biomass grinding process by maintaining negative pressure in the enclosed grinding systems. • Install and operate high-efficiency wet scrubbers on biomass fermentation and distillation operations for volatile organic compound and hazardous air pollutant control. • Install and operate condensers on biomass process vents for volatile organic compound control. • Reduce nitrogen oxide emissions from the mixed-fuel boilers by utilizing a selective non-catalytic reduction system. • Equip ethanol and denaturant storage tanks with internal floating roof designs to control volatile organic compound and hazardous air pollutant emissions. • Route emissions from ethanol loadout to a vapor recovery system for volatile organic compound and hazardous air pollutant control. • Control equipment leaks that would result in emissions of fugitive volatile organic compounds and hazardous air pollutants through the use of a leak detection and repair protocol.
Geology and soils
• Minimize wind and water erosion of soils during and after construction by wetting for dust control during soil disturbance, timely reclamation of disturbed areas, and adherence to requirements established in a storm water pollution prevention plan.
Surface water
• Conduct a wetland survey and assessment on the suspect wetland area within the buffer area and submit to the Kansas State Regulatory Office of the Corps of Engineers for their concurrence or comment. • Prepare, submit, and implement a storm water pollution prevention plan for construction activities to minimize soil loss during storm events.

Table 6-1. Best management practices under consideration (continued).

- Implement erosion and sediment control measures during construction, such as:
  - Construct access control measures to minimize the amount of area disturbed;
  - Cut and fill slopes in a manner that minimizes erosion;
  - Use sediment control measures such as silt fences or straw bale barriers; and
  - Protect culverts from unfiltered or untreated runoff.
- Use secondary containment for bulk fuel storage tanks and for the chemical storage area.
- Use double-walled fuel tanks for emergency generators.
- Construct the tank loading and unloading area and the anhydrous ethanol process areas with trench drains that discharge to a concrete containment basin.
- Develop a spill prevention and countermeasures control plan for petroleum products and other hazardous materials to identify equipment necessary to respond to spills; include procedures to identify federal, state, and local notification requirements should a reportable release occur; and identify appropriate cleanup actions.

Groundwater

- Implement water supply line leak detection inspections as part of routine operation and maintenance program to prevent system losses, and thereby minimize groundwater use.
- Meter groundwater use to ensure compliance with established limits.
- Prepare a conservation management plan for application of non-contact waste to the buffer area to preclude waste of water and attain maximum beneficial reuse of wastewater. The plan should include, but not be limited to, a means to minimize soil erosion, manage soil nutrients, establish irrigation application rates based on types of vegetation and their moisture requirements, and identify the mechanics of applying the wastewater.

Biological resources

- Provide development plans for the off-site biomass storage locations to the Kansas Department of Wildlife and Parks, U.S. Fish and Wildlife Service, and Oklahoma Department of Wildlife and Parks to ascertain whether these locations would affect high-quality native prairie, known lesser prairie chicken leks, black-tailed prairie dog colonies, or any designated critical habitats for threatened and endangered species.

Utilities, energy, and materials

- Implement procedures and equipment that would minimize the use of utility services, energy, and materials.
- Notify potentially affected utility owners prior to construction and coordinate with the owners to avoid or minimize impacts to utilities. Contact Kansas One-Call prior to any excavation associated with construction of the biorefinery.
- Minimize disturbance around areas of underground utilities. Ensure that work crossing any buried utility line would not be started until material and equipment were available for immediate use. Complete work as quickly as possible; keep exposure of existing utilities to a minimum and surround the utility line with appropriate backfill material.

Wastes and hazardous materials

- Provide ash from the solid biomass boiler to biomass producers (as part of a voluntary program) for use as a soil amendment (beneficial byproduct) for nutrient replacement.

Table 6-1. Best management practices under consideration (continued).

- Recover and sell lignin as a beneficial byproduct (e.g., replacement for phenol as a wood binder).
- Manage excess construction materials to minimize generated waste. Excess construction materials would be returned to vendors, retained for future use, or transferred in settlement with subcontractors.
- Recycle construction material waste, as feasible, to reduce solid waste disposal.
- Recycle captured process solids through the solid biomass boiler for energy recovery.
- Dispose non-recycled solid wastes from construction and facility operations in permitted solid waste disposal facilities in Kansas.
- Store, transfer, and dispose of hazardous wastes generated during biorefinery operations in accordance with state and federal regulations.
- Recover and recycle process wastewater treated onsite and reuse in the production process. Non-contact wastewater and wastewater treatment plant sludge would be land-applied.
- Conduct an agronomy study to assess the impacts to soil and vegetation due to application of non-contact wastewater and wastewater treatment facility sludge on the buffer area.
- Adhere to manufacturer guidelines regarding the handling, storage, and application of herbicides, pesticides, and rodenticides used to maintain the biorefinery.
- Adhere to state and federal regulations when handling, storing, or disposing of (shipping offsite for disposal) hazardous materials/wastes.

Visual resources

- Decrease visual obscurants caused by fugitive dust emissions during construction by using control measures such as water spraying, chemical treatment and wind fences.
- Reduce visual obscurants caused by fugitive dust emissions from roads during operation by chemical stabilization, water spraying, and posting low speed limits.
- Control visible emission plumes by maintaining no more than a 20 percent opacity limit.

Noise

- Construction
  - Control noise at the source whenever possible.
  - Use appropriate silencing equipment for construction equipment.
  - Select quietest working equipment available, such as electric/battery-powered equipment, which is generally quieter than diesel-powered equipment.
  - Position equipment behind physical barriers or provide lined and sealed acoustic covers for equipment that could potentially contribute to a noise nuisance.
  - Shut down equipment when not in use and maintain no idling policy.
  - Switch all audible warning systems to the minimum setting.
  - Confine construction activities to normal working hours to the extent possible.
  - Use noise abatement measures for construction during nighttime hours, e.g. silencers on equipment and tools, sound barriers, and avoidance of noisy work outside of buildings.

Table 6-1. Best management practices under consideration (continued).

- Employ proper hearing protection for workers when needed. • Operations - Employ proper hearing protection for workers when needed. - Post signs indicating where hearing protection is needed. - Implement hearing conservation program, engineering controls (e.g. silencers, sound barriers, acoustic panel enclosures), and/or provide personal protective equipment as needed.
Odor
• Reduce odorous emissions though the use of equipment that controls volatile organic compounds and hazardous air pollutants. Control equipment includes wet scrubbers on fermentation and distillation systems and floating internal roof designs on ethanol storage tanks.
Cultural resources
• Cease construction should buried cultural resources be exposed by trenching or below-grade excavation until such time as a qualified archaeologist examines the resources and the Kansas State Historical Society is notified. • Provide development plans for the off-site biomass storage locations to the Kansas State Historical Preservation Office to ascertain the potential for these locations to contain significant cultural resources. If the potential is deemed to be relatively high, follow protocols of the Office to determine whether the resources require further investigation, are potentially eligible for inclusion on the National Historic Register or State Historical Register, or whether other locations should be considered for biomass storage.
Health and safety
• Comply with safety and health regulations during the construction process. These steps include, but are not limited to, instructing employees in the recognition and avoidance of unsafe conditions, keeping debris cleared from work areas, wearing appropriate personal protective equipment, maintaining equipment in proper working condition, having fall protection systems in place, and using appropriate signage to warn of dangers and potential hazards. • Develop operating procedures to ensure compliance with regulatory requirements and which provide consistency throughout the facility to minimize confusion and possible errors. • Perform process hazard analyses on those tanks within the facility that may contain more than 10,000 pounds (4,536 kilograms) of flammable liquid. The purpose of the analyses would be to identify possible deviations from process design or operations that could cause injury to personnel, or could adversely affect the public. The analyses would then develop recommendations to further reduce the likelihood of an accident or to reduce the possible severity of an accident if it were to occur. • Establish administrative limits to restrict the amount or concentration of regulated chemical substances to meet compliance requirements. This includes (1) maintaining the chemical supply at 19 percent aqua ammonia or less or if greater than 19 percent, limiting total storage quantity to 20,000 pounds (9,072 kilograms) of solution, and (2) using denaturant that is rated 3 or lower by the National Fire Protection Association or limiting total storage quantity to 10,000 pounds (4,536 kilograms).

6.2 Mitigation

Mitigation measures are defined by the Council on Environmental Quality regulations (Title 40 of the Code of Federal Regulations 1508.20) as:

“(a) Avoiding the impact altogether by not taking a certain action or parts of an action

(b) Minimizing impacts by limiting the degree or magnitude of the action and its implementation

(c) Rectifying the impact by repairing, rehabilitating, or restoring the affected environment

(d) Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action

(e) Compensating for the impact by replacing or providing substitute resources or environments."

DOE regards mitigation measures as activities or actions that would be above and beyond (in addition to) best management practices and, therefore, does not include them in the Proposed Action and Action Alternative (or the corresponding environmental impact analyses of Chapter 4). Table 6-2 lists mitigation measures under consideration by DOE for the Proposed Action and Action Alternative.

Table 6-2. Mitigation measures under consideration.

Air quality
• Use well-maintained construction equipment having appropriate emissions controls.
Visual resources
• Maintain the current visual status of the buffer area over time by only utilizing the land in the buffer area for agricultural activities.
• Reduce the impacts from night lighting at the biorefinery by using downward-facing or directional lighting and the minimum amount of lighting needed for safe operation.
Odor
• Control odorous emissions through the use of an odor control plan, which would identify sources of odorous emissions, controls used on those sources, operation and maintenance plans with schedules for routine maintenance of the control equipment, and a response plan if any of the control equipment fails to meet specifications. The operation and maintenance plans and schedules would be evaluated and updated over time to ensure improvements are recognized and incorporated as appropriate.
Socioeconomics
• Initiate timely communication with local and regional organizations to disseminate information relative to the construction schedule and expected worker influx to assist in planning for increased demand on community services.
Wastes and hazardous materials
• Develop a waste management and pollution prevention plan prior to contracting facility construction. • Identify landfills for the disposal of solid and industrial wastes during construction and operation of the biorefinery. Construction specifications should direct contractors where to recycle/dispose construction generated wastes.
Transportation
• Stagger workforce schedules to minimize traffic delays and congestion on nearby roadways. • Develop safety-based criteria to be used, in part, to select carriers (truck). Criteria should include elements of the Federal Motor Carrier Safety Administration regulations (see next bullet), as well as provisions for drivers to be paid hourly and receive bonuses for accident-free driving, mandatory safety training, and avoidance of teen-age drivers and drivers having less than 5-years experience.

Table 6-2. Mitigation measures under consideration (continued).

• Require carriers and drivers to meet the Federal Motor Carrier Safety Administration regulations that establish: commercial driver license standards, requirements, and penalties; general qualifications for drivers and rules for driving a commercial motor vehicle: hours of service limits for drivers; safety fitness standards; motor carrier safety regulations; minimum levels of financial responsibility for motor carriers; requirements to test drivers for controlled substance and alcohol use; and driver training requirements.
• Require safety training protocols/programs for selected carriers.
• Ensure the onsite rail system is sufficient to handle unit trains without blocking railroad crossings near the *Biorefinery Project site* for long periods of time.
• Maximize the use of rail for shipments to and from the Project site.

Chapter 7

Unavoidable Adverse Impacts; Short-Term Uses and Long-Term Productivity; Irreversible and Irretrievable Commitments of Resources

CONTENTS

7. UNAVOIDABLE ADVERSE IMPACTS; SHORT-TERM USES AND LONG-TERM PRODUCTIVITY; IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

In accordance with the *National Environmental Policy Act* (NEPA), Section 102 (42 U.S.C. 4332) and the Council on Environmental Quality NEPA implementing regulations (40 CFR 1502.16), this chapter addresses:

- Any adverse environmental impacts U.S. Department of Energy (DOE or Department) and/or the U.S. Department of Agriculture (USDA) would not be able to avoid if the Department implemented the *Proposed Action* or Action Alternative.

- The relationship between local short-term uses of the environment within the region of influence and the maintenance and enhancement of long-term productivity.

- Any irreversible and irretrievable commitments of resources if DOE implemented the Proposed Action or Action Alternative.

During the engineering and site evaluation and planning phases for the *biorefinery*, the Department and the USDA considered many factors to avoid or minimize the potential environmental impacts and would continue to consider these factors in deciding whether to provide federal funds for the design, construction, and startup of the biorefinery. DOE and/or USDA would require the Abengoa Biorefinery Project to meet all applicable regulatory requirements during construction and operations and would require an array of *best management practices* to ensure compliance with requirements (see Chapter 6 of this Abengoa Biorefinery Project EIS). Further, as described in Chapter 6, DOE and/or the USDA could require the implementation of measures to *mitigate* any impacts remaining after final design and compliance with regulatory requirements and implementation of best management practices.

However, there could be unavoidable adverse impacts; impacts to short-term uses and long-term productivity resources; and/or irreversible and irretrievable commitment of resources, for example:

- Abengoa Bioenergy could mitigate most of the potential impacts described in Chapter 4, but there would be some unavoidable impacts, for example, the use of farmlands for the Biorefinery Project site;

- Construction would involve a short-term peak in employment for biorefinery construction and startup. This peak would recover to a normal operations employment level after construction and startup are completed; and/or

- There could be an irreversible commitment of resources such as consumption of *fossil fuel*.

This chapter summarizes and consolidates information from Chapters 4 and 6 of this EIS.

7.1 Unavoidable Adverse Impacts

Engineering and site evaluation and planning are the first steps in undertaking a proposed action. Next follows compliance with all laws, regulatory requirements, and stipulations and conditions of associated permits to minimize environmental- and health-related impacts. Best management practices are implemented to maintain compliance with these requirements. Where analyses identify potential environmental impacts, mitigation measures are implemented to avoid, minimize, rectify, reduce, or compensate for those impacts. Finally, unavoidable adverse impacts may arise where there are no reasonably practicable mitigation measures to entirely eliminate impacts, and there are no reasonably practicable alternatives to the Abengoa Biorefinery Project that would meet the purpose and need of the action, eliminate the impact, and not cause other or similar significant adverse impacts.

Unavoidable adverse impacts would not vary substantially between the Proposed Action and Action Alternative. The following sections describe unavoidable adverse impacts, if any, for each environmental resource area evaluated in this EIS.

7.1.1 LAND USE

Use of land for construction and operation of the biorefinery would involve some long-term changes in land use. The Proposed Action would include the direct conversion of land due to the construction of the biorefinery. The 385-acre (1.6-square kilometer) *biorefinery parcel* is currently used for dryland row-crop farming and grazing, but has been conditionally rezoned to Heavy Industrial. Therefore, construction and operation of the biorefinery would not conflict with local land use plans or goals. The 425-acre (1.7-square-kilometer) *buffer area* would remain in agricultural production and the Agricultural District zoning would not change. DOE would need to implement best management practices to avoid or minimize potential adverse impacts related to construction of the biorefinery.

Approximately 235 acres (0.95 square kilometer) of the total biorefinery parcel is *prime farmland if irrigated*. All *prime farmland* in Stevens County is qualified “if irrigated.” The biorefinery parcel is not irrigated and represents 0.17 percent of all prime farmland within Stevens County alone. The percentage is substantially lower compared with all prime farmland within the *region of influence*. Similarly, the biorefinery parcel represents approximately 0.01 percent of all cropland within the region of influence. While minor relative to the region of influence, the loss of cropland is unavoidable. However, this loss of cropland is expected to have a beneficial economic impact.

Crop *residue* removal at the magnitude needed to meet biorefinery demand is largely unprecedented. Therefore, there is no consensus on sustainable crop *residue* removal rates. DOE would need to implement best management practices to avoid, minimize, or mitigate adverse impacts to *feedstock* production land. The Proposed Action includes best management practices to minimize wind erosion, which is the predominant soil resource concern within the region of influence. The best management practices would also serve to minimize, but may not sufficiently minimize, adverse impacts to *soil organic matter* content. Though the current state of the industry recognizes potential adverse impacts to soil organic matter content, it does not support specific mitigation measures for soil organic matter content. On a regional basis, the Department anticipates crop residue removal based on soil erosion rates would have a negligible impact on soil organic matter content. On a field-by-field basis, the Department anticipates crop residue removal would have a beneficial to minor adverse impact on soil organic matter content. Any adverse impact to soil organic matter content would be limited to the individual producer’s land that would be compensated for residue removal.

7.1.2 AIR QUALITY

Construction of the biorefinery near Hugoton, Kansas, would cause unavoidable impacts to the regional *air quality*. During the construction phase, land disturbance and vehicle traffic on unpaved roads would produce temporary *fugitive dust* emissions. Construction equipment and other machinery would emit tailpipe emissions including diesel *particulate matter*, nitrogen dioxide, sulfur dioxide, and carbon monoxide. Abengoa Bioenergy would reduce the emissions through good operational practices such as watering or *chemical* stabilization of unpaved roads and disturbed surfaces, avoiding vehicle trackout from the site, posting speed limits, practicing reduced equipment idling time, scheduling construction activities to reduce multiple emission sources occurring simultaneously, and using well-maintained, modern equipment with exhaust controls. The unavoidable emissions generated during construction would therefore be minimized and occur on a temporary basis.

Operations of the biorefinery would also cause unavoidable impacts to the regional air quality. During the operations phase, air pollutant concentrations of regulated pollutants, including carbon monoxide, nitrogen oxide, sulfur dioxide, and particulate matter with aerodynamic diameter less than or equal to 10 micrometers (PM_{10}), would be generated. *Best available control technologies* and best management practices would be in place to reduce the emissions significantly and to meet air quality regulatory standards as conditions of an air quality permit required prior to construction through the Kansas Department of Health and Environment, Bureau of Air and Radiation. However, the emissions cannot be controlled completely and therefore would result in unavoidable impacts. The modeled ambient pollutant concentrations from the operations of the biorefinery, summarized in Tables 4.2-3 and 4.2-6 in Chapter 4, in addition to existing background concentrations, are well below the *National Ambient Air Quality Standards*. Therefore, any unavoidable *ambient air* quality impacts resulting from the operation of the biorefinery would not be significant.

7.1.3 HYDROLOGY

7.1.3.1 Surface Water

The Proposed Action would involve the presence of *hazardous materials* that otherwise would not be at the *Biorefinery Project site*. These materials could be released accidently and subsequently be transported by surface water runoff. During the construction phase, potential contaminants would consist mostly of petroleum fuels and lubricants. During the operations phase, hazardous materials present would involve acid and *caustic* solutions, liquid ammonia, urea, enzymes, and several other process chemicals, as well as the ethanol, gasoline denaturant, and diesel fuel that would all be stored onsite. The potential for releases or spills to occur, and their severity, would be minimized by incorporating secondary containment features into the biorefinery and by following planned actions in the facility's Spill Prevention, Control, and Countermeasures Plan. In addition, the biorefinery would be designed so that under most storm conditions, no runoff could leave the biorefinery parcel. In the event runoff was great enough to flood the low areas within this parcel, overflow would run to adjacent properties to the south or to the buffer area to the east. These adjacent areas are internally drained, so there would be no mechanism to move contamination far from the Project site.

7.1.3.2 Groundwater

Operation of the biorefinery would cause irreversible and irretrievable commitment of *groundwater* resources, as the water rights would consume an allocation of the usable volume of the *aquifer* storage and, to some extent, restrict additional use within the area while the biorefinery was in operation and the water rights were valid.

7.1.4 BIOLOGICAL RESOURCES

Construction and operation of the biorefinery for either the Proposed Action or Action Alternative would result in some minor adverse impacts; however, these impacts would be only to common wildlife species at the Biorefinery Project site and immediately adjacent areas. There are no *endangered or threatened species* present within or immediately adjacent to the Project site.

Adverse impacts to threatened and endangered species from *biomass offsite storage locations* could be avoided with proper screening and placement. Therefore, no direct impacts to threatened and endangered species within the 30-mile (48-kilometer) region of influence are expected from the Proposed Action or Action Alternative.

7.1.5 UTILITIES, ENERGY, AND MATERIALS

Construction and operation of the biorefinery would result in the unavoidable use of energy and materials. Under the Proposed Action, energy use would consist of natural gas and diesel fuel; under the Action Alternative (without the electrical co-generation component), electrical energy from the regional power grid would also be used. Materials would include general construction materials such as concrete, asphalt, and earthen fill materials, but would also include various manufacturing materials, including steel and stainless steel. The consumption of energy and construction material would not be large enough to affect national or regional supplies. Further, the electrical co-generation component of the Proposed Action would add electrical energy into the regional grid for use by other entities.

7.1.6 WASTES, BYPRODUCTS, AND HAZARDOUS MATERIALS

The generation of *solid wastes* (that is, construction/demolition debris, plastics, papers, cartons, steel waste, pipes, cables, metal containers, and inorganic municipal solid wastes) would be unavoidable during the construction phase. Abengoa Bioenergy would handle all wastes in accordance with applicable regulations and would implement best management practices and pollution prevention and waste minimization programs. As described in Chapter 4, Section 4.6.1.1, DOE estimated that 35,000 tons (32,000 metric tons) of solid waste would be generated during the 18-month construction phase of the biorefinery, for a daily rate of about 78 tons (71 metric tons). Further, the estimated solid waste generated due to the increase in worker population during the construction phase would be 1.2 tons (1.1 metric tons) per day. The non-recycled construction wastes would be disposed of in active, permitted solid waste disposal facilities within the region of influence. Permitted municipal solid waste facilities in Kansas are allowed to receive the construction wastes listed above. The wastes meeting the Kansas definition of *construction and demolition waste* could also be disposed of at a *construction and demolition waste landfill*. The Stevens County landfill would not have adequate capacity to receive the construction wastes generated under the Proposed Action and maintain its small arid landfill exempt status [20-ton (18-metric ton) daily operating limit]. The non-recycled construction waste streams could be split among various permitted landfills and transfer stations within the region of influence, and the bulk of the construction and demolition waste could be received by the Grant County construction and demolition landfill. Splitting the construction waste among landfills would require permission from the selected facilities to receive the wastes.

As described in Chapter 4, Section 4.6.1.3, DOE estimated that 33,600 tons (30,500 metric tons) of dirt and *fines* resulting from biomass processing and 33 tons (30 metric tons) of municipal solid waste and construction debris would be generated annually during the operations phase, for a daily rate of 96.1 tons (87.2 metric tons) (350 operating days per year). Further, the estimated solid waste generated due to the increase in population during the operations phase would be 0.3 ton (0.27 metric ton) per day. This additional solid waste would increase the waste stream to the Stevens County landfill from 13.3 to 109.7 tons (12.1 to 99.5 metric tons) per day. Based on these observations, DOE concludes there is not adequate capacity at the Stevens County landfill to receive solid waste generated during the operations phase of the biorefinery without modification of its small arid landfill exempt status. The operations phase waste stream could be split among various permitted landfills and transfer stations within the region of influence. Splitting the operations phase solid waste among landfills would require permission from the selected facilities to receive the wastes.

The *solid biomass boiler* would generate about 80,000 tons (72,600 metric tons) per year [228 tons (207 metric tons) per operating day] of ash under the Proposed Action. Abengoa Bioenergy would market and sell the ash *byproduct* to biomass producers as a lower-cost, value-added nutrient replacement co-product. If Abengoa sold the nutrient replacement ash, it would not require disposal as a solid waste in a permitted solid waste disposal facility. If the solid boiler ash was not sold as a nutrient replacement byproduct, it would require disposal at a permitted solid waste disposal facility. Stevens County landfill would not have adequate capacity to receive this quantity of ash without a permit modification. This waste stream could be split among permitted landfills and transfer stations within the region of influence, but this would require permission from the selected facilities to receive the waste.

The biorefinery would generate approximately 1 ton (0.9 metric ton) per year of *hazardous waste* (such as, gasoline, spent solvents, laboratory packs, paint wastes, used oil, waste ethanol, acids, caustics, cleaners, waste lamps, and batteries). All hazardous wastes generated at the biorefinery would be treated by incineration or disposed of at a licensed treatment or disposal facility.

Although the use of those treatment or disposal facilities would be unavoidable, existing disposal facilities have ample capacity to handle all additional wastes.

7.1.7 TRANSPORTATION

During the construction and anticipated 30-year operations phases, there would be an estimated 32 traffic fatalities under the Proposed Action and 13 traffic fatalities under the Action Alternative. The majority of these fatalities would be due to shipments of biomass, chemicals, *denatured ethanol* product, and waste. For perspective, over the expected 30-year operations phase, there would an estimated 13,400 traffic fatalities in Kansas and 820 traffic fatalities in the nine counties surrounding the Biorefinery Project site. While these impacts are small relative to the number of traffic fatalities in Kansas and the nine counties surrounding the Project site, they would not be completely unavoidable.

7.1.8 AESTHETICS

7.1.8.1 Visual Resources

The biorefinery would cause unavoidable visual impacts. During the construction phase, land disturbance and vehicle traffic on unpaved roads would produce temporary visual impacts from the increased equipment and vehicles and resulting dust emissions. Abengoa Bioenergy would control the visible dust emissions with dust suppression methods such as chemical stabilization and watering. Once the biorefinery was constructed and operational, the structures would be visible from Hugoton and elsewhere, but would be similar in height and appearance to existing, nearby structures. Water vapor plumes from the biorefinery would also be visible, especially during winter.

7.1.8.2 Noise

The Proposed Action would lead to an unavoidable increase in *ambient noise* from construction of the biorefinery. This would be a temporary adverse impact because of the temporary nature of the construction phase. During operations, noise from truck traffic would be an unavoidable adverse impact. Noise from truck traffic would adversely impact residences, including a residential area in the northwest corner of the city of Hugoton and a residence at the northwest Biorefinery Project site boundary. The truck bypass would alleviate impacts to the residential area in the northwest corner of Hugoton. However, the two residences on Road Q just west of U.S. Highway 56 would be along the bypass and would then experience these impacts. The Stevens County Hospital and several residences, schools, and places of worship along Kansas State Highway 51 in the city of Hugoton would also experience some unavoidable adverse impacts from truck noise.

7.1.8.3 Odor

Construction and operations of the biorefinery would cause unavoidable emissions of some odorous compounds. During the construction phase, tailpipe emissions from diesel equipment would be a source of temporary odors, as well as odorous emissions from the application of asphalt during road construction. During the operations phase, unavoidable emissions of odorous compounds would occur. Based on a modeling analysis, the concentrations of odorous compounds would dissipate below referenced threshold levels beyond the fence line at locations where people would most likely be located, including the nearby businesses, golf course, houses, parks, and schools. Although the biorefinery would cause unavoidable emissions of odorous compounds, the offsite impacts would small.

7.1.9 SOCIOECONOMICS

Unavoidable impacts from construction and operations of the biorefinery would affect, to a small degree, population, housing, employment, education, and public services in Morton, Seward, and Stevens counties, Kansas, and in Texas County, Oklahoma. *Socioeconomic* changes during the construction phase would include a brief elevation in project-related employment, temporary population increases, including increases in the school-aged population, and proportional and immediate impacts on existing levels of public services (such as law enforcement, fire protection, and medical services). Impacts on housing would be unavoidable but small because of the nature of housing often selected by construction workforces and the large inventory of vacant housing in the region. Abengoa Bioenergy has determined that the greatest impacts would be economic, and, although unavoidable, would be generally viewed as beneficial and not adverse. As outlined in Chapter 4, Section 4.9 of this Abengoa Biorefinery Project

EIS, construction-related impacts in Morton, Seward, Stevens, and Texas counties would result in small increases in peak employment. Increase in employment would result in increased spending of wages, which in turn would create indirect jobs and increase tax revenues. Socioeconomic changes during operations would include increases in direct project-related employment and indirect positions created by operational worker wages being spent. The greatest impacts during operations would also be economic and, although unavoidable, would be generally viewed as beneficial and not adverse. There would be very small long-term population increases. Because the population increases would be small, impacts to public services, including educational services, would also be small albeit unavoidable.

7.1.10 CULTURAL RESOURCES

Based on DOE review of published information, coordinating with the State Historic Preservation Office and the results of the Phase I/II investigation, construction and operation of the biorefinery, including the buffer area, would not result in adverse impacts to State or National Historic register sites within the 1-mile (1.6-kilometer) region of influence. The specific locations of offsite storage are not yet known; however, the storage sites would not be located within or immediately adjacent to any sites listed with the National Historic Register or Kansas State Historical Society.

DOE does not expect any impacts to graves or American Indians concerns as a result of the Proposed Action or Action Alternative.

7.1.11 HEALTH AND SAFETY

There would be a potential for injuries or fatalities to workers during construction and operation of the biorefinery due to common industrial hazards and accidents. Common industrial accidents and their associated injuries would not be completely avoidable. Safety programs and best management practices would reduce, but not eliminate, the potential for worker injuries or fatalities.

7.1.12 ENVIRONMENTAL JUSTICE

No impacts to communities with high percentages of *minority* and *low-income* populations were identified that would exceed impacts identified for the general population. In addition, the Department identified no unique exposure pathways, sensitivities, or cultural practices would result in different impacts on minority or low-income populations. Disproportionately high and adverse impacts would be unlikely as a result of the Proposed Action and Action Alternative.

7.2 Relationship Between Short-Term Uses and Long-Term Productivity

Council on Environmental Quality regulations that implement the procedural requirements of NEPA require consideration of “the relationship between short-term uses of man’s environment and the maintenance and enhancement of long-term productivity” (40 CFR 1502.16). This includes using “… all practicable means and measures, including financial and technical assistance, in a manner calculated to foster and promote the general welfare, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generation of Americans” (NEPA, Section 101, 42 U.S.C. 4331).

This section discusses the short-term use of the environment and the maintenance of its long-term productivity. Chapter 4 of this EIS provides more-detailed discussions of the impacts and resource utilization associated with the Proposed Action and Action Alternative.

The Proposed Action supports long-term productivity of land use relative to the current conditions. Most of the land within the region of influence is utilized for agricultural production. The Proposed Action would primarily utilize crop residues, a byproduct of existing grain production. The long-term use of crop residues for energy production is largely unprecedented. The Proposed Action includes best management practices to minimize adverse impacts associated with crop residue removal. However, the extent of the impact to soil conditions is the subject of ongoing research.

The increased water demand during the projected life of the biorefinery would have a small impact on the Hugoton water system. Use of groundwater for facility operations would not adversely affect groundwater supplies from the High Plains aquifer, as the biorefinery demand would be a reduction over that which would have occurred if the four wells and associated demand were to have remained a source of irrigation water.

7.3 Irreversible and Irretrievable Commitments of Resources

NEPA Section 102 (42 U.S.C. 4332) and Council on Environmental Quality regulations that implement the procedural requirements of NEPA (40 CFR 1502.16) require that environmental analyses include identification of "… any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented." An irreversible commitment of resources represents a loss of future options. It applies primarily to nonrenewable resources, such as minerals or *cultural resources*, and to those factors that are renewable only over long time spans, such as soil productivity; whereas, an irretrievable commitment of resources represents opportunities that are foregone for the period of the Proposed Action. Examples include the loss of production, harvest, or use of renewable resources. The decision to commit resources is reversible, but the utilization of opportunities foregone is irretrievable.

This section describes irreversible and irretrievable commitments of resources associated with implementation of the Proposed Action and Action Alternative. Irreversible and irretrievable commitments of resources would not meaningfully vary between the Proposed Action and Action Alternative.

7.3.1 LAND USE

Construction of the biorefinery and resultant infrastructure and development construction is considered an irreversible commitment of land use. However, construction of the biorefinery is consistent with local land use goals.

Biorefinery consumption of biomass is considered an irretrievable commitment of resources. Consumption by the biorefinery could effectively reduce available livestock feed within the region of influence. Livestock producers that control use of the land from which their feed is derived are expected to be largely unaffected. Livestock producers that rely on biomass from land not under their control could be impacted by a reduction in available livestock feed. DOE does not consider this indirect *opportunity cost* to a non-landowner an adverse impact. Replacement of nutrients removed through biomass harvesting is common agricultural practice and supported by Abengoa Bioenergy's optional Nutrient Replacement Program. The decision to irretrievably commit biomass to the biorefinery would be made by individual producers. Producers that willingly enter the biomass purchase contract would have deemed the compensation adequate for the loss of conservation functions (such as soil moisture management). To the unlikely extent that producers would jeopardize their own long-term soil productivity, the Proposed Action includes best management practices for residue removal.

7.3.2 AIR QUALITY

Operation of the biorefinery would cause irretrievable commitments of air quality resources, as it would consume allowable air quality increments even though the air quality impacts would be well below the National Ambient Air Quality Standards and required best management practices would be implemented. Air quality increments, along with baseline concentrations from the area of interest, define air quality impact levels that all sources in the baseline area of interest cannot exceed in order to prevent degradation of air quality in the area of interest.

7.3.3 HYDROLOGY

7.3.3.1 Surface Water

DOE has not identified any *jurisdictional wetlands* that would be affected by the Proposed Action. Surface water drainage would be limited to areas within the Biorefinery Project site, which encompasses the buffer area. Offsite storage locations would not be in areas of *depressions*, where runoff might accumulate. Therefore, DOE did not identify any associated irreversible and irretrievable commitments of surface water resources.

7.3.3.2 Groundwater

The Proposed Action would consume 2,170 acre-feet (2.7 million cubic meters) of water per year, and the Action Alternative would consume 850 acre-feet (1.0 million cubic meters) of water per year. The *consumptive use* is less than the currently approved quantity of 7,240 acre-feet (8.9 million cubic meters) per year for the Proposed Action and 2,200 acre-feet (2.7 million cubic meters) per year for the Action Alternative. The use of groundwater could be considered an irretrievable commitment of resources (see discussion in Chapter 4, Section 4.3.1.2).

7.3.4 BIOLOGICAL RESOURCES

Construction and operation of the biorefinery under the Proposed Action and Action Alternative could result in some minor adverse impacts. Any impacts, although irreversible, would be only to common wildlife species on and immediately near the Biorefinery Project site.

7.3.5 UTILITIES, ENERGY, AND MATERIALS

Construction and operation of the biorefinery would result in the unavoidable use of energy and materials. Under the Proposed Action, energy use would consist of natural gas and diesel fuel; under the Action Alternative (without the electrical co-generation component), electrical energy from the regional power grid would also be used. Materials would include general construction materials such as concrete, asphalt, and earthen fill materials, but would also include various manufacturing materials, including steel and stainless steel. The consumption of energy and construction material would not be large enough to affect national or regional supplies. Further, the electrical co-generation component of the Proposed Action would add electrical energy into the regional grid for use by other entities. These impacts, though minor, would be irreversible.

7.3.6 WASTES, BYPRODUCTS, AND HAZARDOUS MATERIALS

DOE identified the irreversible loss of land used for landfills. DOE did not identify any other irreversible and irretrievable commitments of resources related to the Proposed Action or Action Alternative for wastes, byproducts, and hazardous materials.

7.3.7 TRANSPORTATION

For the Proposed Action and the Action Alternative, fossil fuels such as diesel fuel and gasoline would be consumed during the transport of materials for the construction and operations phases. Under the Proposed Action, there would be about 150 million round-trip miles (240 million round-trip kilometers) of truck and rail traffic and about 39 million round-trip miles (63 million round-trip kilometers) of commuting worker traffic during the construction and operations phases. This would consume about 24 million gallons (91 million liters) of diesel fuel and gasoline. Under the Action Alternative, there would be about 100 million round-trip miles (160 million round-trip kilometers) of truck and rail traffic and about 32 million round-trip miles (51 million round-trip kilometers) of commuting worker traffic during the construction and operations phases. This would consume about 16 million gallons (61 million liters) of diesel fuel and gasoline.

7.3.8 AESTHETICS

7.3.8.1 Visual Resources

The visual contrast of the biorefinery to the existing agricultural land would cause irreversible and irretrievable changes in the *viewshed* in the Hugoton area. The structures of the biorefinery would be similar in height and appearance to some existing, nearby structures that are visible from Hugoton, the industrial park, and the Forewinds Golf Course.

7.3.8.2 Noise

DOE did not identify any irreversible and irretrievable commitments of resources related to the Proposed Action or Action Alternative for noise.

7.3.8.3 Odor

DOE did not identify any associated irreversible and irretrievable commitments of resources due to the presence of odorous compounds emitted from the biorefinery because there are no regional odor restrictions and the odors naturally dissipate with time and distance.

7.3.9 SOCIOECONOMICS

DOE did not identify any irreversible and irretrievable commitments of resources related to the Proposed Action or Action Alternative for socioeconomics.

7.3.10 CULTURAL RESOURCES

DOE did not identify any irreversible and irretrievable commitments of resources related to the Proposed Action or Action Alternative for cultural resources.

7.3.11 HEALTH AND SAFETY

There would be a potential for injuries or fatalities to workers during construction and operation of the biorefinery due to common industrial hazards and accidents. Common industrial accidents and their associated injuries could not be completely avoidable. Safety programs and best management practices would reduce, but not eliminate, the potential for worker injuries and fatalities.

7.3.12 ENVIRONMENTAL JUSTICE

DOE determined that constructing and operating the biorefinery would not cause high or adverse impacts to, or fall disproportionately on, minority or low-income populations. Thus, DOE did not identify any associated irreversible and irretrievable commitments of resources related to the Proposed Action or Action Alternative that would present an *environmental justice* concern.

Chapter 8

Regulations

CONTENTS

8. REGULATIONS

This chapter describes the U.S. Department of Energy's (DOE or the Department) analysis of statutes, regulations, permits, licenses, and entitlements that establish or affect the implementation of the Proposed Action and Action Alternative for this Abengoa Bioenergy Project EIS.

8.1 Federal Statutes

This section describes relevant provisions of those federal statutes germane to the underlying purpose and need for DOE's action as described in Chapter 1, Section 1.1. These statutes include the *Energy Policy Act of 2005* (EPAct 2005; Pub. L. 109-58) and the *Energy Independence and Security Act of 2007* (Pub. L. 110-40).

8.1.1 ENERGY POLICY ACT OF 2005

The purpose of EPAct 2005, as established by the U.S. Congress, is to ensure jobs for the future with secure, affordable, and reliable energy. Section 932 is the key provision of EPAct 2005 relevant to the development of commercial-scale integrated biorefineries, and to the issuance of loan guarantees for renewable energy systems, respectively. As a general matter, Section 932 directs the Department to undertake research, development, demonstration, and commercial application for bioenergy, including integrated biorefineries that produce biopower, biofuels, and bioproducts. More specifically, Section 932 identifies that the goals of the biofuels and bioproducts programs are to develop:

1. Advanced biochemical and thermochemical conversion technologies capable of making fuels from lignocellulosic feedstocks that are price-competitive with gasoline or diesel in either internal combustion engines or fuel cell-powered vehicles;

2. Advanced biotechnology processes capable of making biofuels and bioproducts with emphasis on development of biorefinery technologies using enzyme-based processing systems;

3. Advanced biotechnology processes capable of increasing energy production from lignocellulosic feedstocks, with emphasis on reducing the dependence of industry on fossil fuels in manufacturing facilities; and

4. Other advanced processes that will enable the development of cost-effective bioproducts, including biofuels.

In addition, Section 932 allows DOE to provide funds (limited to $100 million for any single biorefinery demonstration) to support the:

- Demonstration of a wide variety of lignocellulosic feedstocks;

- Commercial application of biomass technologies for a variety of uses, including, liquid transportation fuels, high-value biobased chemicals, substitutes for petroleum-based feedstocks and products, and energy in the form of electricity or useful heat; and

- Demonstration of the collection of treatment of a variety of biomass feedstocks.

8.1.2 ENERGY INDEPENDENCE AND SECURITY ACT OF 2007

The purpose of the *Energy Independence and Security Act of 2007*, in part, is to move the United States toward greater energy independence and security by increasing the production of renewable fuels, and promoting research on and deploying greenhouse gas capture and storage options. Title II, Subtitle A of the Act extends and increases the renewable fuel standard set previously by EPAct 2005. The renewable fuel standard requires minimum annual levels of renewable fuel in transportation fuel. Under EPAct 2005, the previous standard was 5.4 billion gallons (20 billion liters) for 2008, rising to 7.5 billion gallons (28 billion liters) by 2012. Under the *Energy Independence and Security of 2007*, the new standard starts at 9 billion gallons (34 billion liters) in 2008 and rises to 36 billion gallons (140 billion liters) in 2022.

In addition, starting in 2016, all of the increase in the renewable fuel standard target must be met with advanced biofuels, defined as cellulosic ethanol and other biofuels derived from feedstock other than corn starch, with explicit amounts for cellulosic biofuels and biomass-based diesel fuel. The U.S. Environmental Protection Agency (EPA) may temporarily waive part of the biofuels mandate, if it were to determine that a significant renewable feedstock disruption or other market circumstance might occur. Furthermore, renewable fuels produced from new biorefineries will be required to reduce by at least 20 percent the lifecycle greenhouse gas emissions relative to lifecycle emissions from gasoline and diesel. Fuels produced from biorefineries that displace more than 80 percent of the fossil-derived processing fuels used to operate a biofuel production facility qualify for cash awards.

8.2 Federal and State Environmental Requirements

This section lists other federal (Section 9.2.1) and state (Section 9.2.2) environmental requirements applicable to implementation of the Proposed Action and Action Alternative. The *National Environmental Policy Act* is discussed in Chapter 1, Section 1.4.

8.2.1 FEDERAL STATUTES AND REGULATIONS

The federal statutes applicable to the Proposed Action and Action Alternative include the following:

- National Environmental Policy Act (42 U.S.C. 4321-4370)
- Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531-1543)
- Fish and Wildlife Coordination Act (16 U.S.C. 661 et seq., as amended)
- Migratory Bird Treaty Act (16 U.S.C. 703 et seq., as amended)
- Bald and Golden Eagle Protection Act (16 U.S.C. 668 through 668d)
- Clean Water Act of 1977 (CWA) and the Water Quality Act of 1987 (WQA) (33 U.S.C. 1251 et seq., as amended)
- Farmland Protection Act of 1981 (7 U.S.C. 4201 et seq., as amended)
- Food Security Act of 1985, 16 U.S.C. 3801 through 3862 et seq., as amended
- Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) (as amended by the Superfund Amendments and Reauthorization Act of 1986 [SARA])
- Resource Conservation and Recovery Act of 1976 (RCRA) (42 U.S.C. 6901 et seq., as amended)
- Toxic Substances Control Act (TSCA) (15 U.S.C. 2601 et seq., as amended)
- Safe Drinking Water Act of 1974 (42 U.S.C. 300(f) et seq., as amended)
- Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA) (42 U.S.C. 1001 et seq.)

- National Historic Preservation Act of 1966 (NHPA) (16 U.S.C. 470 et seq., as amended)
- Archeological Resources Protection Act of 1979 (16 U.S.C. 470 et seq., as amended)
- Clean Air Act of 1970 (CAA) (42 U.S.C. 7401 et seq., as amended)
- Noise Control Act of 1972 (42 U.S.C. 4901-4918)
- Hazardous Materials Transportation Act (49 U.S.C. 1801 et seq.)
- Pollution Prevention Act of 1990 (42 U.S.C. 13101 et seq.)
- American Indian Religious Freedom Act of 1978 (42 U.S.C. 1996)
- Native American Graves Protection and Repatriation Act of 1990 (25 U.S.C. 3001)
- Antiquities Act (16 U.S.C. 431 et seq.)
- Homeland Security Act of 2002 (6 U.S.C. 101 et seq.)
- National Primary Drinking Water Regulations (40 CFR Part 141)
- Criteria for Municipal Solid Waste Landfills (40 CFR Part 258)
- Federal Noxious Weed Act of 1974 (FNWA) (7 U.S.C. 2801-2814, as amended).

8.2.2 STATE OF KANSAS STATUTES AND REGULATIONS

The Kansas statutes applicable to the Proposed Action and Action Alternative include, but are not necessarily limited to, the following:

- Kansas Statutes Annotated (K.S.A), Chapter 65 – Public Health, Article 34 – Solid and Hazardous Waste and Administrative Regulations
- Kansas Surface Water Quality Standards (K.A.R. 28-16-28 et seq.)
- Kansas Statues Annotated 65-164 and 65-165
- Kansas Anti-degradation Policy dated August 6, 2001
- Kansas Administrative Regulations (K.A.R.) Chapter 28, Air Quality Regulations, Article 19, Ambient Air Quality Standards and Air Pollution Control
- Kansas Administrative Regulations (K.A.R.) Chapter 28, Primary Drinking Water Regulations, Article 15a
- Kansas Statutes Annotated (K.S.A.), Chapter 2 – Agriculture, Article 13 – The Kansas Noxious Weed Law, April 2007
- Kansas Water Appropriation Act (K.S.A. 82a-701 et seq.)
- Kansas Obstructions in Stream Act (K.S.A. 82a-301 to 305)
- Kansas Drainage and Levees Act (K.S.A. 24-126)
- Kansas Statutes Annotated (K.S.A), Chapter 32 – Wildlife, Parks and Recreation, Article 9 – Licenses, Permits, Stamps and Other Issues, 32-957 through 32-963, 32-1009 through 32-1012, 32-1033 and K.S.A. 32-960a and 32-960b, as amended.

8.3 DOE Regulations and Policies

The DOE regulations and policies applicable to the Proposed Action and Action Alternative include the following:

- DOE Compliance with the National Environmental Policy Act (10 CFR Part 1021)
- DOE Compliance with Floodplain and Wetland Environmental Review Requirements (10 CFR Part 1022)

- DOE Order 451.1B, National Environmental Policy Act Compliance Program (Change 1, September 28, 2001)
- DOE Policy 430.1, Land and Facility Use Planning (July 9, 1996) (with Secretary of Energy Memorandum, December 21, 1994)
- DOE Policy 141.1, Management of Cultural Resources (May 2001).

8.4 Executive Orders

The executive orders applicable to the Proposed Action and Action Alternative include the following:

- Executive Order 11514, Protection and Enhancement of Environmental Quality (amended by Executive Order 11991)
- Executive Order 11990, Protection of Wetlands
- Executive Order 12372, Intergovernmental Review of Federal Programs
- Executive Order 11988, Floodplain Management
- Executive Order 12088, Federal Compliance with Pollution Control Standards
- Executive Order 12856, Right-to-Know Law and Pollution Prevention Requirements
- Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations
- Executive Order 13007, Indian Sacred Sites
- Executive Order 13045, Protection of Children from Environmental Health Risks and Safety Risk
- Executive Order 13010, Critical Infrastructure
- Executive Order 13025, Amendment to Executive Order 13010, the President's Commission on Critical Infrastructure Protection
- Executive Order 13112, Invasive Species
- Executive Order 13175, Consultation and Coordination with Indian Tribal Governments
- Executive Order 13186, Responsibilities of Federal Agencies to Protect Migratory Birds
- Executive Order 13423, Strengthening Federal Environmental, Energy, and Transportation Management

8.5 Permits, Licenses, and Entitlements

This section lists environmental permits, licenses, and entitlements that may be applicable to implementation of the Proposed Action and Action Alternative.

- EPA Spill, Prevention, Control and Countermeasures (SPCC) plan in accordance with 40 CFR Part 112
- EPA Chemical Accident Prevention Provisions (40 CFR Part 68), Risk Management Program, Risk Management Plan
- U.S. Department of Labor Occupational Safety and Health Administration, Process Safety Management of Highly Hazardous Chemicals Regulation (29 CFR 1910.119), Process Safety Management Plan
- U.S. Department of Labor Occupational Safety and Health Administration, Occupational Noise Exposure (29 CFR 1910.95)
- U.S. Department of Labor Occupational Safety and Health Administration, Safety and Health Regulations for Construction (29 CFR Part 1926)

- U.S. Department of Agriculture Land Evaluation and Site Assessment (implements provisions of the Farmland Policy Protection Act of 1981)
- Kansas General National Pollutant Discharge Elimination System Storm Water Permit for Construction Activities in compliance with Kansas State General Permit S-MCST-0701-1 and Federal Permit No.: KSR100000, and in compliance with Kansas Statutes Annotated 65-164 and 65-165; the Federal Water Pollution Control Act (33 U.S.C. 1251 et seq.; the "Clean Water Act"); and the Kansas Surface Water Quality Standards (K.A.R. 28-16-28 et seq.)
- Kansas National Pollutant Discharge Elimination System Permit for Storm Water Discharges associated with Industrial Activities in compliance with Kansas State General Permit S-ISWA-0507-1 and Federal Permit No.: KSR000000, and in compliance with Kansas Statues Annotated 65-164 and 65-165; the Federal Water Pollution Control Act (33 U.S.C. 1251 et seq.; the "Clean Water Act"); and the Kansas Surface Water Quality Standards (K.A.R. 28-16-28 et seq.)
- Kansas Industrial Wastewater Pre-Treatment Discharge Permit in compliance with the Surface Water Quality Standards (K.A.R. 28-16-56) and the Kansas Anti-degradation Policy dated August 6, 2001
- Kansas Air Quality Construction and Major Source Title V Air Permits in compliance with Chapter 28, Kansas Air Quality Regulations, Article 19, Ambient Air Quality Standards and Air Pollution Control
- Kansas Hazardous Waste Generator Identification Number in accordance with Kansas Statutes Annotated (K.S.A), Chapter 65 – Public Health, Article 34 – Solid and Hazardous Waste and Administrative Regulations and U.S. Environmental Protection Agency 40 CFR Part 262
- Kansas Odor Control Plan in compliance with K.A.R. Chapter 28, Department of Health and Environment, Article 19, Chemical Processing Facilities that Operate Alcohol Plants or Liquid Detergent Plants (K.A.R. 28-19-77)
- Kansas Water Pollution Control Permit (sewage lagoons) in compliance with K.A.R. Chapter 28, Article 16, Water Pollution Control, Section 16-1, Sewage Discharge Permits
- Kansas Landfill Permit in compliance with K.A.R. Chapter 28, Article 29, Solid Waste Management
- Kansas Water Appropriations for change in water use application, Kansas Division of Water Resources in accordance with K.A.R. 5-5-9
- Kansas Aboveground Storage Tank Registration in compliance with K.A.R. Chapter 28, Department of Health and Environment, Article 44, Aboveground Storage Tank Operating Permit (K.A.R. 28-44-29).

Chapter 9

Contributors

1. CONTRIBUTORS

This chapter lists the individuals who filled primary roles in the preparation of this Abengoa Biorefinery Project EIS. Kristin Kerwin of the U.S. Department of Energy (DOE or Department) Golden Field Office directed the preparation of this EIS. The Abengoa Biorefinery Project EIS Team, led by Richard Holder of Jason Associates Corporation, provided primary support and assistance to DOE; other members of the team include AGEISS Inc., Kleinfelder, Inc., Lechel, Inc., and Battelle Memorial Institute.

DOE provided direction to the Abengoa Biorefinery Project EIS Team, which was responsible for developing the analytical methodology and alternatives, coordinating the work tasks, performing the impact analyses, and producing the document. DOE was responsible for data quality, the scope and content of the Abengoa Biorefinery Project EIS, and issue resolution and direction.

The applicant, Abengoa Bioenergy, provided preliminary design and operations data necessary for evaluating the impacts for the Abengoa Biorefinery Project EIS. Mr. Christopher Roach, the Abengoa Bioenergy Project Development Manager, acted as the point of contact for DOE in gathering this data. Because design and operations data were transmitted to DOE and/or the EIS Team from Mr. Roach via email, the emails became references for this EIS.

DOE independently evaluated all supporting information and documentation prepared by these organizations. Further, DOE retained the responsibility for determining the appropriateness and adequacy of incorporating any data, analyses, and results of other work performed by these organizations in this Abengoa Biorefinery Project EIS. The Team was responsible for integrating such work in the EIS document.

As required by federal regulations [40 CFR 1506.5(c)], Jason Associates Corporation and its subcontractors have signed *National Environmental Policy Act* (NEPA) disclosure statements in relation to the work they performed on the Abengoa Biorefinery Project EIS. These statements appear at the end of this chapter.

Name	Education	Experience	Responsibility
		U.S. Department of Energy	
Kristin Kerwin	M.P.S., Environmental Science, Policy and Democratic Processes, 2002 M.P.A., Public Administration, 2002 B.S., Environmental Studies, Policy and Management, 1999	5 years – environmental specialist for the DOE Golden Field Office; 2 years – facilitating projects related to best management practices for agriculture and water quality.	DOE Document Manager
Gene Petersen	Ph.D., Chemistry, 1976 B.A., Chemistry, 1970	5 years as DOE Project Manager in the Golden Field Office; 23 years experience in research and development at NASA and DOE laboratories in areas related to biotechnology, biomass to chemicals and fuels, and space habitation.	Field project office for the Abengoa Biorefinery Project near Hugoton, Kansas

Name	Education	Experience	Responsibility
Christy Sterner	B.S., Chemical Engineering, 1996	9 years – project management/monitoring of biomass-related projects, DOE Golden Field Office; 5 years research and development, process engineering, lab analysis related to extraction technologies.	Project engineer for the Abengoa Biorefinery Project near Hugoton, Kansas
		Abengoa Biorefinery Project EIS Team	
Ernest C. Harr, Jr., Jason Associates Corporation	B.S., Zoology/ Chemistry 1977	30 years – DOE and commercial programs and projects, radiological programs, environmental monitoring, and radioactive materials and waste management.	Project Manager
Richard Holder Jason Associates Corporation	M.B.A., Business Administration, 1986 M.S. Electrical Engineering, 1970 B.S. Electrical Engineering, 1966	40 years – team and line management for nuclear, utility, industrial, and overseas projects.	Project Manager; Lead Analyst: Summary, Unavoidable Impacts; Comment Response Document
Zia Abdullah, Battelle Memorial Institute	M.B.A., Technology Management, 2007, PhD Mech. Eng. 1987, BS Mech. Eng. 1982, PMP 2008	27 years – various roles in utilities, pulp and paper companies, research and development, new product development, boiler systems, fermentation systems, and project management.	Transportation analysis support
Kris (Vernon) Allen, Kleinfelder, Inc.	B.S., Environmental Restoration and Waste Management, 1996 A.S., Physics, 1994	12 years – environmental planning, compliance, and permitting including California Environmental Quality Act and NEPA project support.	Technical Analyst: Air Quality, Odor, Visual Resources
Frank Arnwine, Kleinfelder, Inc.	B.S., Geology 1985	21 years – geology and hydrogeology, contaminated site investigation and remediation , project and program management (19 years Kansas regulatory experience).	Lead Analyst: Hydrology – Groundwater, Geology and Soils
Tonya Bartels, AGEISS Inc.	M.S., Analytical Chemistry, 1994 B.S., Chemistry, 1991	9 years – NEPA project support.	Lead Analyst: Noise
Pixie Baxter, Jason Associates Corporation	M.B.A., Economics, 1981 B.A., Art History	20 years – multidisciplinary economic and business experience including 15 years as economics college faculty member.	Lead Analyst: Socioeconomics

Name	Education	Experience	Responsibility
Keith Davis, P.E., Jason Associates Corporation	M.S., Civil/ Environmental Engineering, 1976 B.S., Civil Engineering, 1973	32 years – civil and environmental engineering; waste management; facility permitting and closure; site investigations, feasibility studies, and remedial action planning; 15 years – NEPA documentation.	Lead Analyst: Hydrology – Surface Water, Utilities, Energy, Materials
Peter R. Davis, Jason Associates Corporation	Oak Ridge School of Reactor Technology 1962 B.S., Physics, 1961	45 years – nuclear reactor and nuclear facility safety analysis and risk assessment.	Lead Analyst: Facility Accident Scenarios
Paul Fransioli, CCM, QEP; Kleinfelder, Inc.	M.S. Atmospheric Physics, 1972 B.S., Physics, 1967	35 years – meteorology and environment for EPA, U.S. Nuclear Regulatory Commission, and NEPA programs, doing air monitoring, modeling, and analysis; with 17 years of operations under nuclear quality assurance (NQA-1).	Quality check, data consistency; Review air modeling data and documents
Cherie Jarvis, Kleinfelder, Inc.	B.S., Life Science 1995	13 years – Environmental programs and projects, data management, data visualization, and geographical information systems (GIS).	GIS Graphics Production Manager
Deborah Jerez, Kleinfelder, Inc.	M.A., Geology, 1987	27 years – geology, NEPA, compliance, regulatory analysis; 2 years – quality assurance, corrective action planning/implementation.	Data consistency
Dave Lechel, Lechel Inc.	M.S., Fisheries Biology, 1974 B.S., Fisheries Biology, 1972	30 years – preparing and managing preparation of NEPA documents.	Lead Analyst: Purpose and Need for Agency Action; Mitigation Measures; Cumulative Impacts analysis; Regulations summary
Scott Mackiewicz, Kleinfelder, Inc.	Ph.D., Civil Engineering, Geotechnical and Environmental, 1994 M.S., Civil Engineering, Geotechnical, 1991 B.S., Civil Engineering, 1990	14 years – preparing documents and managing geotechnical and environmental projects.	Lead Analyst: Wastewater

Name	Education	Experience	Responsibility
Cynthia Madden, AGEISS Inc.	3 years of college toward B.S. in Management/Computer Science	11 years – Wall Street IT consultant; 5 years – financial and program management support.	Production Team: IT support, Web site development
Steven Maheras, Battelle Memorial Institute	Certified Health Physicist, 1992 Ph.D., Health Physics, 1988 M.S., Health Physics, 1985 B.S., Zoology, 1982	19 years – transportation risk assessment and radiological assessment, environmental and occupational radiation protection.	Lead Analyst: Transportation
Thomas I. McSweeney, Battelle Memorial Institute	Professional Engineer State of Ohio, Chemical Engineering Ph.D., Chemical Engineering, 1967 M.A., Math, 1964 M.S., Chemical Engineering, 1961 B.S., Chemical Engineering, 1960	Over 25 years – risk assessment of radiological and hazardous material transportation, facility risk, hazards analyses, and safety assessment.	Analyst: Transportation
Lisa Messinger, Kleinfelder, Inc.	M.A., Geography/GIS (pending thesis) B.S., Geology, 2000	9 years – GIS, 4 years of GIS analysis in NEPA document preparation and contaminant cleanup; 3 years – regulatory project management (Kansas Department of Health and Environment) in contaminant investigations and cleanup.	GIS Graphics Lead
Brent Peterson, Kleinfelder, Inc.	B.S., Biological and Agricultural Engineering, 1998	10 years – site investigations, engineering, permitting and planning.	Lead Analyst: Land Use
Tom Plattner, Kleinfelder, Inc.	M.S., Environmental Studies, 1990 B.S., Biology, 1983	19 years – NEPA analysis and biological resources planning and permitting for endangered species, Waters of the U.S., and hazardous waste releases.	Lead Analyst: Biological Resources, Cultural Resources, Wetlands and Floodplains appendix
Christijo Plemons, Jason Associates Corporation	2 years of college courses	19 years – marketing and general office.	Production Team: Graphics Production, Web site development, References, Index, Administrative Record

Name	Education	Experience	Responsibility
Kurt Rautenstrauch, Jason Associates Corporation	Ph.D., Wildlife Ecology, 1987 M.S., Wildlife Management, 1984 B.S., Fisheries and Wildlife Biology, 1980	22 years – research, management, and impact analysis for natural resources.	Summary
Pete Schanock, AGEISS Inc.	B.S. Forestry, 1985	20 years – forestry, forest products procurement, resource management; 1 year – marketing and proposal preparation.	Quality Assurance Manager; Data consistency
Meredith Schindler, Kleinfelder, Inc.	B.S., Geological Engineering	2 years – intern work related to geographic information systems.	GIS Graphics Production
Leroy Shaser, AGEISS Inc.	M.S., Geology 1978 B.S., Geology 1976	15 years – environmental compliance regarding NEPA, Comprehensive Environmental Response, Compensation, and Liability Act, and Resource Conservation and Recovery Act; 26 years – GIS and computer mapping.	Lead Analyst: Health and Safety
Michele Steyskal, Kleinfelder, Inc.	M.S., Mechanical Engineering, 2001 B.S., Physical Science, 1999	6 years – engineering and project management at a DOE national laboratory.	Analyst: Air Quality, Odor, Visual Resources
Joanne Stover, Jason Associates Corporation	B.S., Business Administration, 1996	21 years – technical editing, marketing, NEPA document development, and project management.	Production Team: Document Production Manager, Technical Editor, Word Processing, Document Control; Administrative Record; Web site content
Rowley Tedlock, Kleinfelder, Inc.	M.S., Environmental Health Science, 1985 B.S., Biology, 1980	28 years – environmental health science and engineering.	Document Manager; Lead Analyst: Wastes, Byproducts, and Hazardous Materials, Regulations
Susan Walker, AGEISS Inc.	Ph.D., Pathology, 1982 B.S., Zoology, 1975	32 years – toxicology, risk assessment, environmental studies including NEPA and regulatory compliance.	Deputy Project Manager; Data Quality Assurance; Lead Analyst: Proposed Action, Alternative Action, No-Action Alternative, Environmental Justice

NEPA DISCLOSURE STATEMENT FOR
PREPARATION OF THE ENVIRONMENTAL IMPACT STATEMENT FOR THE ABENGOA BIOREFINERY PROJECT NEAR HUGOTON, KANSAS

CEQ regulations at 40 CFR 1506.5(c), which have been adopted by DOE (10 CFR 1021), require contractors who will prepare an EIS to execute a disclosure specifying that they have no financial or other interest in the outcome of the project. The term "financial interest or other interest in the outcome of the project" for purpose of this disclosure is defined in the March 23, 1981, guidance "Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations," (46 FR 18026-18038 at Question 17a and b).

"Financial or other interest in the outcome of the project" includes "any financial benefit such as a promise of future construction or design work in the project, as well as indirect benefits the contractor is aware of (e.g., if the project would aid proposals sponsored by the firm's other clients)" (see 46 FR 18026-18031).

In accordance with these requirements, Jason Associates Corporation hereby certifies it has no financial or other interest in the outcome of the project.

Certified By:

David Hoberg
Signature

DAVID HOBERG
Name (printed)

VP/CFO
Title

JASON ASSOCIATES CORP
Company

5/13/2009
Date

NEPA DISCLOSURE STATEMENT FOR

NEPA DISCLOSURE STATEMENT FOR PREPARATION OF THE ENVIRONMENTAL IMPACT STATEMENT FOR THE ABENGOA BIOREFINERY PROJECT NEAR HUGOTON, KANSAS

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In accordance with these requirements, Kleinfelder, Inc. hereby certifies it has no financial or other interest in the outcome of the project.

Certified By:

[signature]

Signature

K. Michael Cline

Name (printed)

Director of USDOE Programs

Title

Kleinfelder

Company

5/13/09

Date

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In accordance with these requirements, AGEISS Inc. hereby certifies it has no financial or other interest in the outcome of the project.

Certified By:

Signature

Donna B. Lawrence
Name (printed)

President
Title

AGEISS Inc.
Company

May 13, 2009
Date

NEPA DISCLOSURE STATEMENT FOR PREPARATION OF THE ENVIRONMENTAL IMPACT STATEMENT FOR THE ABENGOA BIOREFINERY PROJECT NEAR HUGOTON, KANSAS

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In accordance with these requirements, Lechel, Inc. hereby certifies it has no financial or other interest in the outcome of the project.

Certified By:

David Lechel

Signature

David Lechel

Name (printed)

Vice President

Title

LECHEL, Inc.

Company

May 13, 2009

Date

NEPA DISCLOSURE STATEMENT FOR PREPARATION OF THE ENVIRONMENTAL IMPACT STATEMENT FOR THE ABENGOA BIOREFINERY PROJECT NEAR HUGOTON, KANSAS

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In accordance with these requirements, Battelle Memorial Institute hereby certifies it has no financial or other interest in the outcome of the project.

Certified By:

Digitally signed by LaDonna F. James
DN: cn=LaDonna F. James, o=Battelle Government Contracts, ou=Contracting Officer, email=jamesl@battelle.org, c=US
Date: 2009.05.15 10:42:51 -04'00'

LaDonna F. James

Name (printed)

Contracting Officer

Title

_ Battelle Memorial Institute, Corporate Operations

Company

May 15, 2009

Date

Chapter 10

Glossary

10. GLOSSARY

The U.S. Department of Energy (DOE or the Department) has provided this glossary to assist readers in the interpretation of this Abengoa Biorefinery Project EIS. The Glossary includes definitions of technical and regulatory terms common to DOE *National Environmental Policy Act* (NEPA) documents and explains these terms with their most likely meanings in the context of DOE NEPA documents, and in particular this EIS. DOE derived the definitions in this glossary from the most authoritative sources available (for example, a statute, regulation, DOE directive, dictionary, or technical reference book) and checked each definition against other authorities. Glossary terms are presented in *italics* the first time they appear in each chapter of this document. In this Glossary, the convention is to italicize other glossary terms when they appear in a definition, but only once per definition.

Term	Definition
affected environment	The physical, biological, and human-related environment that is sensitive to changes resulting from the *Proposed Action*. The extent of the affected environment may not be the same for all potentially affected resource areas.
aerobic (digestion)	Biological treatment processes that occur in the presence of oxygen.
agronomy	The science of crop production and soil management.
air quality	A measure of the concentration of pollutants, measured individually, in the air.
airshed	A geographical region sharing a common flow of air in which *ambient air* quality is typically uniform. Because of the nature of air, an airshed is not a precise physical division like a *watershed*, but a political convenience for dealing with air problems that cross municipal and state lines.
ambient air	1. Any unconfined portion of the atmosphere; open air, surrounding air. 2. The surrounding atmosphere, usually the outside air, as it exists around people, plants, and structures. It is the air surrounding emission sources that the public has access to (that is, the air outside of a physical barrier such as a fence).
ambient noise	Sound level at a given location, normally specified as a reference level to study a new intrusive sound source.
anaerobic (digestion)	Biological treatment processes that occur in the absence of oxygen.
anhydrous	Lacking water.
anthropogenic	Referring to alterations in the environment due to the presence or activities of humans.

Term	Definition
aquifer	Rock or sediment in a formation, group of formations, or part of a formation that is saturated and sufficiently permeable to transmit economic quantities of water to wells or springs.
attainment (area)	An area that the U.S. Environmental Protection Agency (EPA) has designated as being in compliance with one or more of the *National Ambient Air Quality Standards* for sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone, lead, and particulate matter. An area may be in attainment for some pollutants but not for others.
attenuate	To lessen or weaken.
A-weighting	A weighting function to the *noise* spectrum that approximates the response of the human ear.
A-weighted decibel	A measurement of sound that approximates the sensitivity of the human ear, which is used to characterize the intensity or loudness of sound.
best available control technologies	The currently available technology producing the greatest reduction of air pollutant emissions, taking into account energy, environmental, economic, and other costs. Determined on a case-by-case basis typically by state or local permitting agencies.
best management practices	For this EIS, the practices, techniques and methods, and processes and activities commonly accepted and used throughout the construction and ethanol production industries to facilitate compliance with applicable requirements, and that provide an effective and practicable means of avoiding or reducing the potential environmental impacts of the *Proposed Action* and Action Alternative.
biofuels	Fuels made from *biomass* resources or their processing and conversion derivatives. Biofuels may include ethanol, biodiesel, and methanol.
biomass	Any organic matter that is available on a renewable or recurring basis, including agricultural crops and trees, wood and wood residues, plants (including aquatic plants), grasses, animal manure, municipal residues, and other residue materials. Biomass is sustainably regenerated.
biopower	The use of *biomass feedstock* to produce electric power or heat through direct combustion of the feedstock, through *gasification* and then combustion of the resultant gas, or through other thermal conversion processes. Power is generated with engines, turbines, fuel cells, or other equipment.
bioproducts	Bioproducts are any products (such as fuels, chemicals, and raw materials) made from renewable resources.

Term	Definition
biorefinery	Biorefineries are similar to petroleum refineries in concept; however, biorefineries use biological matter (*biomass*), as opposed to petroleum, to produce transportation fuels (for example ethanol), chemicals, and heat and power. Such transportation fuels, chemicals, and heat and power are referred to as *biofuels*, *bioproducts*, and *biopower*, respectively. An integrated biorefinery uses combinations of biomass *feedstocks* (for example, corn stover, wheat straw, and other nonfood crop residues) and conversion technologies to produce a variety of products, but typically biofuels. In this EIS, the term “biorefinery” refers to the physical structures, including associated infrastructure, of the biomass-to-ethanol and biomass-to-energy production facility.
biorefinery area/ parcel	The western 385 acres of the *Biorefinery Project site* where the biorefinery and facilities would be located.
Biorefinery Project site	The location in Stevens County, Kansas, where Abengoa Bioenergy would build the biomass-to-energy and electricity facility. The Project site comprises 810 acres of cropland, the western 385 acres would contain the *biorefinery* and facilities; 425 acres on the eastern side would be a *buffer area* between the *biorefinery parcel* and the city of Hugoton.
bituminous	Like or containing any of various mixtures of hydrocarbons and other substances, occurring naturally or obtained by *distillation* from coal or petroleum, found in asphalt and tar, and used for surfacing roads and for waterproofing.
buffer area	The eastern 435 acres of the *Biorefinery Project site* that would remain cropland during construction and operation of the *biorefinery*.
byproducts	Products made during the production, manufacture, processing, or syntheses of something else.
candidate species	A species of plants or animals classified as a candidate for possible listing as endangered or threatened by a government agency.
capacity margin	The amount of unused available capability of an electric power system at peak load as a percentage of capacity resources.
cathodic protection wells	A term used for certain measures taken to prevent or minimize electrolytic corrosion of metallic equipment and structures. Cathodic protection wells house devices to minimize electrolytic corrosion of metallic pipelines, tanks, and other facilities in contact with the ground. Sometimes called “deep groundbeds.”

Term	Definition
caustic	Causing corrosion.
cellulase	A class of enzymes that catalyze the hydrolysis of *cellulose*.
cellulose	1. The structural component of the primary cell wall of green plants. 2. An organic compound consisting of a linear chain of several hundred to over ten thousand glucose molecules (polysaccharide). Cellulose is broken down to simple sugars during *enzymatic hydrolysis*.
cellulosic biomass	See *lignocellulosic*.
cellulosic ethanol	An alternative fuel made from a wide variety of non-food plant materials (or *feedstocks*), including agricultural wastes such as corn stover and cereal straws, industrial plant waste like saw dust and paper pulp, and energy crops grown specifically for fuel production like switchgrass.
cellulosic feedstock	See *lignocellulosic*.
cellulosic hydrolysis	See *enzymatic hydrolysis*.
chemicals	Substances with a specific chemical composition. Some chemicals would be classified as *hazardous materials* and others not.
co-firing (bioenergy systems)	The combustion of two types of materials at the same time.
colluvial	Characteristic of a loose deposit of rock debris accumulated through the action of rainwash or gravity at the base of a gently sloping cliff or slope.
confined aquifer	An *aquifer* that is overlain by a *confining bed*. The confining bed has a significantly lower hydraulic conductivity than the aquifer.
confining bed	A body of material of low hydraulic conductivity that is stratigraphically adjacent to one or more aquifers. It may lie above or below the aquifer.
conformity	Consistent with separate general and transportation conformity rules in which federal agencies must work with state, Tribal, and local governments in nonattainment and maintenance areas to ensure that federal actions, including highway and transit projects, conform to the initiatives established in the applicable state or Tribal implementation plan.

Term	Definition
Conservation Reserve Program	A major provision of the Food Security Act of 1985 designed to reduce erosion and protect water quality on farmland. Under the program, enrolled landowners agree to convert environmentally sensitive land to approved conserving uses for 10 to 15 years. In exchange, the landowner receives an annual rental payment for establishing permanent vegetative cover.
conservation till	Refers to a variety of tillage systems that balance profitable crop production while minimizing erosion.
construction and demolition waste	In Kansas, construction and demolition waste means solid waste resulting from the construction, remodeling, repair, and demolition of structures, roads, sidewalks, and utilities. Such wastes include, but are not limited to, bricks, concrete, and other masonry materials, roofing materials, soil, rock, wood, wood products, wall or floor coverings, plaster, drywall, plumbing fixtures, electrical wiring, electrical components containing no *hazardous materials*, non-asbestos insulation, and construction-related packaging.
construction and demolition waste landfill	*Solid waste* disposal area used exclusively for the disposal on land of construction and demolition wastes.
consumptive irrigation	The amount of water applied for irrigation of a crop that is taken up by the plant *biomass* and which is transpired by the plant and that evaporates.
consumptive use (groundwater)	That part of water that is evaporated, transpired, used in products, incorporated into crops, consumed by humans or livestock, or otherwise removed from the water environment.
continental climate	A climatic type associated with the interior of large land masses in mid-latitudes. Without the moderating influence of the sea, summer and winter temperatures are extreme. Precipitation is low, as the region is distant from moisture-bearing winds.
contour farming	Field operations such as plowing, planting, cultivating, and harvesting on the contour, or at right angles to the natural slope, to reduce soil erosion, protect soil fertility, and use water more efficiently.
cover crop	A crop grown between periods of regular production of the main crop for the purposes of protecting the soil from erosion and improving soil productivity, health, and quality.
criteria pollutants	Six common pollutants (ozone, carbon monoxide, *particulate matter*, sulfur dioxide, lead, and nitrogen dioxide) known to be hazardous to human health and the environment and for which the EPA sets *National Ambient Air Quality Standards* under the Clean Air Act.

Term	Definition
critical habitats	A specific geographic area(s) that is essential for the conservation of a *threatened or endangered species* and that may require special management and protection. The lists of critical habitats can be found in 50 CFR 17.95 (fish and wildlife), 50 CFR 17.96 (plants), and 50 CFR 226 (marine species).
crop rotation	System of cultivation where different crops are planted in consecutive growing seasons to maintain soil fertility.
cultural resources	Cultural resources include, but are not limited to, the following broad range of items and locations: • archaeological materials (artifacts) and sites that date to the prehistoric, historic, and ethnohistoric periods and that are currently located on the ground surface or buried beneath it; • standing structures and/or their component parts that are over 50 years of age and are important because they represent a major historical theme or era, including the Manhattan Project and the Cold War era and structures that have an important technological, architectural, or local significance; • cultural and natural places, select natural resources, and sacred objects that have importance for American Indians; and • American folklife, traditions, and arts. Cultural resources include “historic properties” as defined in the National Historic Preservation Act, “archaeological resource” as defined in the Archaeological Resources Protection Act, and “cultural items” as defined in the Native American Graves Protection and Repatriation Act.
cumulative impact	An impact on the environment that results from the incremental impact(s) of an action added to impacts from other past, present, and *reasonably foreseeable* future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions that take place over a period of time.
day-night average sound level	Describes an individual’s cumulative exposure from all sources of *noise* over a full 24 hours, with any noise exposure occurring between 10 p.m. and 7 a.m. increased by 10 *decibels* (dBA) to account for an individual’s greater nighttime sensitivity to noise.

Term	Definition
days away from work	One of the measures the U.S. Department of Labor, Bureau of Labor Statistics uses when developing statistics related to workplace injuries, illnesses, and fatalities.
days of restricted work activity or job transfer	One of the measures the U.S. Department of Labor, Bureau of Labor Statistics uses when developing statistics related to workplace injuries, illnesses, and fatalities.
denatured ethanol	Ethanol that has been rendered unfit for human consumption by the addition of a denaturant such as gasoline.
depressions	A landform sunken or depressed below the surrounding area. Depressions may be formed by various mechanisms and may be referred to by a variety of technical terms.
direct-firing (bioenergy system)	A technology that uses *biomass* as solid fuel in biomass boilers to produce steam.
direct impacts (socioeconomics)	Those changes that are directly attributed to the Proposed Action, such as changes in employment, population, or spending.
dispersion modeling	Models typically used in the permitting process to estimate the concentration of pollutants at specified ground-level receptors surrounding an emissions source.
distillation	Any of various heat-dependent processes used to purify or separate a fraction of a relatively complex substance, especially the vaporization of a liquid mixture with subsequent collection of components by differential cooling to condensation.
diurnal	Active in the daytime.
dryland cropland	Land used to produce crops in semiarid regions without the use of irrigation.
earthquake hazard	Geology-related hazard typically considered to relate to earthquake shaking action and ground motion.
economic geology	The study of fuels, metals, and other materials from the earth that are of interest to industry or the economy in general. It is concerned with the distribution of resources, the costs and benefits of their recovery, and the value and availability of existing materials.
ecoregions	Areas of similar topography, weather patterns, soils, and vegetation.

Term	Definition
endangered species	Plants or animals that are in danger of extinction through all or a significant portion of their ranges and that have been listed as endangered by the U.S. Fish and Wildlife Service or the National Marine Fisheries Service following the procedures outlined in the *Endangered Species Act* and its implementing regulations (50 CFR 424; K.A.R. 32-958).
environmental impact statement	The detailed written statement that is required by section 102(2)(C) of NEPA for a proposed major federal action, significantly affecting the quality of the human environment. A DOE EIS is prepared in accordance with applicable requirements of the Council on Environmental Quality NEPA regulations in 40 CFR Parts 1500–1508, and the Department of Energy NEPA regulations in 10 CFR Part 1021. The statement includes, among other information, discussions of the environmental impacts of the proposed action and all reasonable alternatives, adverse environmental effects that cannot be avoided should the proposal be implemented, the relationship between short-term uses of the human environment and enhancement of long-term productivity, and any irreversible and irretrievable commitments of resources.
environmental justice	The fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that no group of people, including racial, ethnic, or socioeconomic groups, should bear a disproportionate share of the negative environmental consequences resulting from industrial, municipal, and commercial operations or the execution of federal, state, local, and tribal programs and policies. Executive Order 12898 directs federal agencies to make achieving environmental justice part of their missions by identifying and addressing disproportionately high and adverse effects of agency programs, policies, and activities on minority and low-income populations.
enzymatic hydrolysis	A catalytic decomposition of a *chemical* compound by reaction with water, such as the conversion of cellulosic materials into fermentable sugars by the addition of specific enzymes.
eolian	Borne, deposited, produced, or eroded by the wind.
equivalent sound level	Describes a receiver’s cumulative *noise* exposure from all events over a specified period of time.
fauna	The animals characteristic of a region, period, or special environment.
feedstock procurement area	Area from which most of the *feedstock* is anticipated to be harvested.

Term	Definition
feedstocks	Non-food materials used by the *biorefinery* as the raw material input. A non-food product used as the basis for manufacture of another product.
ferment/fermentation	Ethanol fermentation is the biological process of bacteria and yeast breaking down simple sugars for their cellular energy and producing ethanol and carbon dioxide.
fines	Fine-grained soil particles that are small enough to pass a standard #200 sieve.
floodplain	Flat or nearly flat land adjacent to a stream or river that experiences occasional or periodic flooding.
flora	All plant life occurring in an area or time period, especially the naturally occurring or indigenous plant life.
fluvial	Of or pertaining to rivers or produced by the action of rivers.
fossil fuels	Remains of dead plants and animals of a previous geologic era that can be burned to release energy. Examples are coal, oil, and natural gas.
fugitive dust	*Particulate matter* composed of soil; can include emissions from haul roads, wind erosion or exposed soil surfaces, and other activities in which soil is removed or redistributed.
gasification	For this EIS, a process that converts *biomass* into carbon monoxide and hydrogen by reacting the raw material at high temperatures with a controlled amount of oxygen. The resulting gas mixture is called synthesis gas or *syngas*.
genetically modified organisms	Organisms whose genetic material has been altered using genetic engineering techniques. For this EIS, genetically modified organisms are used in the *enzymatic hydrolysis* process.
geologic hazards	Include natural or manmade conditions or phenomena that present a risk or potential danger to life and property and include such phenomena as landslides, earthquakes, and subsidence related to *karst geology* and mining.
geology	The scientific study of the origin, history, structure, and composition of the earth, mainly through study of its rocks, minerals, and landforms.
geomorphology	The study of the features and landforms and the processes operating upon the earth's surface to produce these features.

Term	Definition
geotechnical	Of or related to geotechnical engineering, which includes investigating existing subsurface conditions and materials; determining their physical/mechanical and chemical properties that are relevant to the project considered, assessing risks posed by site conditions; designing earthworks and structure foundations; and monitoring site conditions, earthwork and foundation construction.
grassland	Areas where the vegetation is dominated by grasses and other non-woody plants.
greenhouse gas	Greenhouse gases are those gaseous constituents of the atmosphere, both natural and *anthropogenic* (resulting from or produced by human beings), which absorb and emit thermal infrared radiation (heat) emitted by the earth's surface, the atmosphere itself, and by clouds. Water vapor, carbon dioxide, nitrous oxide, methane, and ozone are the primary greenhouse gases in the earth's atmosphere. Greenhouse gases trap heat between the earth's surface and the lower part of the atmosphere (troposphere) – the greenhouse effect.
GREET Model	Abbreviation for "Greenhouse gases, Regulated Emissions, and Energy use in Transportation" Model. Examines "well-to-wheel" fuel lifecycles by taking into consideration factors such as producing raw materials for fuels, refining the raw materials into fuels, and using the fuel in vehicles.
groundwater	The water contained in interconnected pores located below the water table in an *unconfined aquifer* or located in a *confined aquifer*.
harvested cropland	As defined in the Census of Agriculture, this category includes land from which crops were harvested and hay was cut. Land from which two or more crops were harvested was counted only once.
hazardous materials	Hazardous materials (also known as dangerous goods) are considered any solid, liquid, or gas that can harm people, other living organisms, property, or the environment.
hazardous waste	A category of waste regulated under the Resource Conservation and Recovery Act (RCRA). To be considered hazardous, a waste must be a solid waste under RCRA and must exhibit at least one of four characteristics described in 40 CFR 261.20 through 40 CFR 261.24 (that is, ignitability, corrosivity, reactivity, or toxicity) or be specifically listed by the EPA in 40 CFR 261.31 through 40 CFR 261.33. Potential hazardous waste streams for the *biorefinery* include gasoline, spent solvents, laboratory packs, paint wastes, used oil, waste ethanol, acids, *caustics*, cleaners, waste lamps, and batteries.

Term	Definition
hemicellulase	A mixture of enzymes that hydrolyzes or breaks down *hemicellulose*.
hemicellulose	1. Polysaccharides present in plant cell walls along with *cellulose*. 2. Any of several branched polysaccharides present in almost all plant cell walls along with *cellulose*. Hemicellulose has a random, amorphous structure with little strength. It is easily hydrolyzed by dilute acid or base as well as myriad hemicellulase enzymes. Hemicellulose is broken down to simple sugars during acid pretreatment.
highly erodible (land)	A measure of the susceptibility of bare soil to be detached and moved by wind or water.
high-quality natural areas	A site that has unique scenic, historic, geologic, biological, or ecological value and of sufficient size and character to allow its maintenance in a natural condition by the operation of physical and biological processes, usually without direct human intervention. High-quality natural areas preserve the biodiversity of the region by contributing to the long-term viability of plant and animal populations, natural communities, landscapes, or ecosystems.
hydraulic conductivity	A measure of the rate at or ease with which water can move through a permeable medium.
hydric soil	A soil that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop *anaerobic* conditions in the upper part.
hydrology	The study of the properties, distribution, and effects of water on a planet's surface, in the soil, and in the atmosphere.
hydrologic units	1. A geographic area representing part or all of a surface drainage basin or distinct hydrologic feature. 2. A classification of soils concerning water infiltration characteristics used in hydrologic analyses. The U.S. Geological Survey has divided the nation into hydrologic units consisting of 21 major regions, which are then subdivided into subregions, accounting units, and finally into the smallest element of the hierarchy, the cataloging unit.
incidence rates	The rate at which new events occur in a population. For this EIS, cases per 100 full-time workers for nonfatality statistics and cases per 100,000 full-time workers for fatality statistics.

Term	Definition
indicator species	Plants and animals that, by their presence, abundance, lack of abundance, or chemical composition, demonstrate some distinctive aspect of the character or quality of an environment.
indirect impacts (socioeconomics)	Those changes that occur as a reaction to the project-induced changes in employment and regional expenditures.
industrial health and safety	Work place safety that focuses on occupational and worker hazards.
interdunal depressions	The area between dunes; see *depressions*.
intermittent (streams)	A stream that only flows for part of the year and is marked on topographic maps with a line of blue dashes and dots.
internal floating roof	The floating roof is used in the tank structure and is floating on the liquid stored within the tank. The floating roof rises and falls with the liquid level within the tank achieving a no vapor zone. The objective of the internal floating roof is to have minimal or eliminate completely the potential gaseous zone above the stored liquid. This is a safety feature required within many industrial storage tank systems. Another benefit of a storage tank internal floating roof is, by removing the gaseous region above the stored liquid, the tank is subjected to less corrosion or oxidizing elements.
jurisdictional wetland	A jurisdictional wetland is one that is within the jurisdictional limits of authority of the U.S. Army Corps of Engineers under the Clean Water Act because the *wetland* also qualifies as a water of the United States. Waters of the United States include all waters that are currently used, or were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of the tide; all interstate waters; and all other waters for which the use, degradation, or destruction could affect interstate or foreign commerce (33 CFR 328.3). Work in waters of the United States, including the discharge of dredged or fill materials, is regulated by the Army Corps of Engineers through issuance of permits..
karst geology	The type of geologic terrain underlain by carbonate rocks where significant solution of the rock has occurred due to flowing *groundwater.*
landslides hazards	A form of earth movement downslope under gravity loads that can be triggered by external forces or environmental conditions.
leks	A gathering of males, of certain animal species, for the purposes of competitive mating display.

Term	Definition
level of service (traffic streams)	A qualitative measure describing operational conditions within a traffic stream based on service measures such as speed and travel time, freedom to maneuver, traffic interruptions, comfort, and convenience.
lignin	A complex *chemical* compound that is an integral part of the cell wall of plants. Lignin fills the spaces in the cell wall between *cellulose*, *hemicellulose*, and *pectin* components. Lignin is not broken down to simple sugars. Lignin would be recovered from the process as a *byproduct* or treated as a waste.
lignocellulosic feedstocks	Any portion of a plant or a *byproduct* used in the conversion of organic materials to energy, including crops, trees, forest wastes, and agricultural wastes not specifically grown for food. These would include, for example, barley grain, grapeseed, rice bran and hulls, soybean matter, corn stover, and organic materials that have been segregated from municipal solid waste. Lignocellulosic (cellulosic) feedstocks would not include, for example, plant-based oils intended for human consumption, such as soy, canola, sunflower and peanut oils, or foods intended for human and animal consumption, such as corn.
listed species	A species of plants or animals listed by a government agency under the Threatened and Endangered Species Act as endangered or threatened.
lithology	The scientific study and description of rocks and soils, especially at the macroscopic level, in terms of their color, texture, and composition.
loam	Soil material that is a mixture of clay, silt, and sand.
low income	Below the poverty level, as defined by the U.S. Bureau of the Census.
managed lands	Federal, state, or private lands that are managed for timber production, wildlife habitat, recreation, education, or other purposes.
marginal cropland	Relative to *prime farmland*, lands that are generally more erodible, droughty, less productive, and cannot be cultivated easily.
marketed energy resources	*Fossil fuels* and petroleum products (such as gasoline and lubricants) whose availability could be affected by a Proposed Action. For purposes of this EIS, marketed energy resources include electricity and natural gas.
metropolitan statistical area	A large population nucleus, together with adjacent communities having a high degree of social and economic integration with that core. Metropolitan areas comprise one or more entire county(ies), except in New England, where cities and towns are the basic geographic units.

Term	Definition
micro area	Geographic entity defined by the U.S. Office of Management and Budget for use by federal statistical agencies in collecting, tabulating, and publishing federal statistics; contains an urban core of at least 10,000 (but less than 50,000) people.
minority	A sociological group that does not constitute a politically dominant voting majority of the total population of a given society. A sociological minority is not necessarily a numerical minority—it may include any group that is subnormal with respect to a dominant group in terms of social status, education, employment, wealth and political power.
mitigate/mitigation	Mitigation includes: 1. Avoiding an impact altogether by not taking a certain action or parts of an action; 2. Minimizing impacts by limiting the degree or magnitude of an action and its implementation; 3. Rectifying an impact by repairing, rehabilitating, or restoring the affected environment; 4. Reducing or eliminating the impact over time by preservation and maintenance operations during the life of an action; or 5. Compensating for an impact by replacing or providing substitute resources or environments.
monocultures	The agricultural practice of producing or growing one single crop over a wide area.
municipal solid waste landfill	A *solid waste* disposal area where residential waste is placed for disposal. A municipal solid waste landfill also may receive other nonhazardous wastes, including commercial solid waste, sludge, and industrial solid waste.
National Ambient Air Quality Standards	Standards established under the authority of the Clean Air Act on a national level that define the maximum allowable limits for airborne concentrations of designated *criteria pollutants* to protect public health with an adequate margin of safety (primary standards) and to protect public welfare, including plant and animal life, visibility, and materials (secondary standards). National *ambient air* quality standards have been established for nitrogen dioxide, sulfur dioxide, carbon monoxide, *particulate matter* with aerodynamic diameters less than 10 microns, particulate matter with aerodynamic diameters less that 2.5 microns, ozone, and lead.

Term	Definition
noise	Unwanted sound that interferes with normal activities or otherwise diminishes the quality of the environment.
nonconsumptive (surface water use)	1. Does not diminish the source or impair future water use; water is diverted and returned immediately to the source at the point of diversion following its use in the same quantity as diverted and meets water quality standards for the source. 2. The water is returned to the stream for renewed use by other water users downstream.
non-point source pollution	Source of pollution in which wastes are not released at one specific, identifiable point but from a number of diffuse points.
no-till	Tillage system where the soil is left undisturbed from harvest to seeding and from seeding to harvest. The only soil disturbance is a narrow slot created during planting.
odor threshold	The theoretical minimum concentration of an odorous compound necessary for detection in the mean percentage of the population.
offsite storage location	For this EIS, refers to where *biomass feedstock* would be stored when not being processed at the *biorefinery*. Current design calls for seven locations within 30 miles (48 kilometers) of the *Biorefinery Project site*. Although these locations have not yet been identified, they would be areas that do not interfere with crop production or irrigation activities, utilize lands that are marginal for crop production, and provide truck access.
opportunity cost	The cost of using a resource for a specific activity relative to using that resource for an alternative activity. The opportunity cost can be economical or functional.
out of production (land)	Land that cannot be developed for crop production because it is enrolled in the *Conservation Reserve Program*, *Wetland Reserve Program*, or other land retirement program.
particulate matter	Fine liquid or solid particles such as dust, smoke, mist, fumes, or smog, found in air or emissions; one of six *criteria pollutants* for which there is a *National Ambient Air Quality Standard*.
pectin	Part of the non-woody parts of terrestrial plants. In the space between plant cells, pectin helps to bind cells together. The amount, structure, and chemical composition of the pectin differs between plants, within a plant over time, and in different parts of a plant. Hard parts of a plant contain more pectin than soft parts. Pectin is broken down to simple sugars during acid pretreatment.

Term	Definition
per capita income	The mean money income received during a calendar year computed for every man, woman, and child in a geographic area. It is derived by dividing the total income of all people 15 years old and over in a geographic area by the total population in that area.
perennial (streams)	A stream or river (channel) that has continuous flow in parts of its bed all year round during years of normal rainfall.
physiographic (region)	Broad-scale subdivisions based on terrain texture, rock type, and geologic structure and history.
playa	A dry or ephemeral lakebed, generally extending to the shore, or a remnant of, a closed basin. Its surface is typically dry, hard, and rough during the dry season, but wet and very soft in the rainy season.
point source	Source of pollution that involves discharge of wastes from an identifiable point, such as a smokestack or sewage treatment facility.
preferred alternative	For this EIS, the preferred alternative represents the most technically and economically viable alternative. The *Proposed Action* is DOE's preferred alternative.
prime farmland	Land that has the best combination of physical and *chemical* characteristics for producing food, feed, fiber, forage, oilseed, and other agricultural crops with minimum inputs of fuel, fertilizer, pesticides, and labor, and without intolerable soil erosion, as determined by the Secretary of Agriculture. Prime farmland includes land that possesses the above characteristics but is being used currently to produce livestock and timber. It does not include land already in or committed to urban development or water storage.
prime farmland if irrigated	Land that meets the definition of *prime farmland* only if it is irrigated.
proposed action	The activity proposed to accomplish a federal agency's purpose and need. An environmental impact statement analyzes the environmental impacts of the proposed action. The Proposed Action for this EIS is for DOE to provide federal funding of approximately $82 million to Abengoa Bioenergy to support the design, construction, and startup of the Abengoa Biorefinery Project.

Term	Definition
protective action criteria values	Concentration limits that produce specific effects for a large number of *chemicals*; used to evaluate health effects of exposure to chemicals. For emergency events/conditions involving the actual or potential release of hazardous materials, each emergency class is defined in terms of the health impact or risk to the general public or site/facility workers. If the impact or risk approaches or exceeds some predetermined level, then steps to protect the public and works should be taken. These predetermined levels, expressed in terms of doses, exposures, or concentrations, are termed “protection action criteria.”
public health and safety	Focuses on hazards that could affect the communities near the *Proposed Action*.
pyrolysis	The chemical decomposition of a condensed substance by heating.
reasonably foreseeable	Future actions for which there is a reasonable expectation that the action could occur, such as a *proposed action* under analysis by a state or federal agency, a project for which construction has started, or an action that has obtained the necessary regulatory approvals or has funding committed to the action.
receptor points	Points at which concentrations of *criteria pollutants* or odorous compounds are computed in the air *dispersion model*.
Record of Decision	A concise public document that records a federal agency’s decision(s) concerning a proposed action for which the agency has prepared an environmental impact statement. The Record of Decision (ROD) is prepared in accordance with the requirements of the Council on Environmental Quality NEPA regulations (40 CFR 1505.2). A ROD identifies the alternatives considered in reaching the decision, the environmentally preferable alternative(s), factors balanced by the agency in making the decision, whether all practicable means to avoid or minimize environmental harm have been adopted, and if not, why they were not.
reduced-till	Tillage system that is less intensive and aggressive than conventional tillage.
region of influence	A specialized term that indicates a specific area of study for each of the resource areas that this EIS analysis addresses.
release parameters	Parameters describing physical properties pertaining to the release of emissions from specific sources such as the emission stack height or emission stack gas flow rate.
renewable energy system	Energy generated from resources that can be replenished, such as *biomass*.

Term	Definition
reservoir	An artificial lake used to store water for various uses.
residue (grain and crop)	Materials left in an agricultural field or orchard after the crop has been harvested. These residues include stalks and stubble (stems), leaves, and seed pods.
sequester	The long-term separation, isolation, or removal of a substance from the atmosphere, including through a biological or geologic method such as reforestation or an underground *reservoir*.
shrink-swell	Related to the expansive nature of soil, or how much the volume of a soil changes when the moisture content changes.
socioeconomics	The study of the relationship between economic activity and social life.
soil collapse	The lowering or collapse of the land surface either locally or over regional areas.
soil organic matter	The plant and animal residue in soil at various stages of decomposition. The content of organic matter in soil can be maintained by returning crop *residue* to the soil. Organic matter has a positive effect on available water capacity, water infiltration, soil organism activity, and tilth. It is a source of nitrogen and other nutrients for crops and soil organisms.
soil-related hazards	Hazards related to the potential for highly erosive soils, expansive soils, and otherwise unstable soil masses.
soil sustainability	Refers to the amount of *residue* that can be removed without adversely impacting soil productivity.
solid biomass boiler ash	The *residue* remaining after the burning of materials such as raw *biomass*, *stillage cake*, thin stillage syrup, and *genetically modified organisms* in the solid biomass boiler.
solid waste	In Kansas, solid waste means garbage, refuse, waste tires and other discarded materials, including, but not limited to solid and semisolid sludges, liquid, and contained gaseous waste materials resulting from industrial, commercial, agricultural, and domestic activities.
source emission rate	The rate of release of a pollutant or compound specific to an individual emission source.
species in need of conservation	Any nongame species deemed to require conservation measures in attempt to keep the species from becoming a threatened or endangered species. Species in need of conservation do not have the level of statutory protection as those species listed as threatened or endangered in Kansas.

Term	Definition
stillage cake	Also known as distiller's residual biomass solids. Insoluble solids recovered from the bottom of the *distillation* column in the distillation process.
stillage syrup	Soluble solids recovered from the *distillation* process and concentrated in an evaporator.
stratigraphy	The study of rock layers and layering.
stationary (noise)	Normally related to specific land uses, for example, housing tracts or industrial facilities.
strip cropping	The growing of crops in a systematic arrangement of strips or bands which serve as vegetative barriers to wind and water erosion. The strips or bands may run perpendicular to the slope of the land or to the direction of prevailing winds.
subsidence	The motion of the earth's surface as it shifts downward relative to sea level.
syngas	The abbreviation for synthesis gas, syngas is a mixture of carbon monoxide, hydrogen, methane, carbon dioxide, and higher hydrocarbon gases. Syngas results from heating *biomass* in the presence of about one-third the oxygen necessary for complete combustion. Syngas has been used successfully in natural gas-based, reciprocating internal combustion engines and gas turbines with only small modifications.
threatened species	Any plants or animals that are likely to become *endangered species* within the foreseeable future throughout all or a significant portion of their ranges and which have been listed as threatened by the U.S. Fish and Wildlife Service or the National Marine Fisheries Service following the procedures set out in the *Endangered Species Act* and its implementing regulations (50 CFR 424; K.A.R. 32-958).
total cropland	As defined in the Census of Agriculture, this category includes *harvested cropland*, cropland used only for pasture or grazing, cropland idle or used for *cover crops* or soil improvement but not harvested and not pastured or grazed, cropland on which all crops failed or were abandoned, and cropland in cultivated summer fallow.
total recordable cases	The total number of work-related deaths, illnesses, or injuries that resulted in the loss of consciousness, *days away from work*, *days of restricted work activity or job transfer*, or required medical treatment beyond first aid.
transient (noise)	Sources that move through the environment, either along established paths or randomly, for example, trains.

Term	Definition
transportation infrastructure	The basic physical and organizational structures needed for the operation of a transportation system.
unconfined aquifer	An *aquifer* that is open to receive water from the surface, and whose water table surface is free to fluctuate up and down, depending on the recharge or discharge rate.
unstable fill	A measure of a soil's tendency to move when it is wet or loaded, or both. Unstable fill can also be suitable for use as subgrade material or fill based on several physical and engineering properties including *shrink-swell*, shear, plasticity, particle size with respect to composition, and other variables.
vent scrubber	An emission control device used to remove particulates and/or gases from exhaust streams.
viewshed	An area of land, water, or other environmental element that is visible to the human eye from a fixed vantage point.
volatile organic matter	Any compound of carbon, excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, and ammonium carbonate, that participates in atmospheric photochemical reactions.
watershed	Land area from which water drains toward a common watercourse in a natural basin.
wetlands	Those areas that are inundated by surface or groundwater with a frequency sufficient to support, and under normal circumstances do or would support, a prevalence of vegetative or aquatic life that requires saturated or seasonally saturated soil conditions for growth and reproduction. Wetlands generally include swamps, marshes, bogs, and similar areas (for example, sloughs, potholes, wet meadows, river overflow areas, mudflats, natural ponds).
Wetland Reserve Program	A voluntary program offering landowners the opportunity to protect, restore, and enhance wetlands on their property. The USDA Natural Resources Conservation Service (NRCS) provides technical and financial support to help landowners with their *wetland* restoration efforts.
Zone A Flood Zone	On Federal Emergency Management Agency flood maps, Zone A designates those areas that would be under water from a 100-year flood.

Chapter 11

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