Appendix E

Air Quality Technical Study

Texas Department of Transportation

TEXAS-OKLAHOMA PASSENGER RAIL STUDY

Air Quality

Technical Study

Texas Department of Transportation

U.S. Department of Transportation
Federal Railroad Administration

July 2016

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Acronyms and Abbreviations

$\mu g/m^3$	micrograms per cubic meter
AAQS	ambient air quality standards
ACOG	Association of Central Oklahoma Governments
BART	Best Achievable Retrofit Technologies
CAA	Clean Air Act
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CO	carbon monoxide
CO_2	carbon dioxide
EDMS	Emissions and Dispersion Modeling System
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
FRA	Federal Railroad Administration
GHG	greenhouse gas
HrSR	higher-speed rail
HSR	high-speed rail
I/M	Inspection and Maintenance
MOA	Memorandum of Agreement
MOVES	Motor Vehicle Emission Simulator
MSATs	Mobile Source Air Toxics
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NO	nitric oxide
NO_2	nitrogen dioxide
NO_x	nitrogen oxides
NCDC	National Climatic Data Center
NOAA	National Oceanic and Atmospheric Administration

O_3	ozone
OAC	Oklahoma Administrative Code
OCS	Oklahoma Climatological Survey
ODEQ	Oklahoma Department of Environmental Quality
Pb	lead
PM	particulate matter
PM_{10}	particulate matter 10 micrometers in diameter or less
$PM_{2.5}$	particulate matter 2.5 micrometers in diameter or less
ppb	parts per billion
ppm	parts per million
Program	Texas-Oklahoma Passenger Rail Program
SIP	state implementation plan
SO_2	sulfur dioxide
SO_x	sulfur oxides
Study	Texas-Oklahoma Passenger Rail Study
TAC	Texas Administrative Code
TCEQ	Texas Commission on Environmental Quality
TERP	Texas Emissions Reduction Plan
TxDOT	Texas Department of Transportation
USDOT	U.S. Department of Transportation
VMT	vehicle miles traveled
VOC	volatile organic compound

1.0 Introduction

The Texas Department of Transportation (TxDOT), along with the Federal Railroad Administration (FRA), is preparing a service-level environmental impact statement (EIS) to evaluate intercity passenger rail service alternatives for the Texas-Oklahoma Passenger Rail Program (Program). The purpose of the Program is to enhance intercity mobility by providing enhanced passenger rail service as a transportation alternative that is competitive with automobile, bus, and air travel. Preparation of the service-level EIS, in support of which this technical study has been prepared, is one of two primary objectives of the Texas-Oklahoma Passenger Rail Study (Study). In addition to the service-level EIS, TxDOT and FRA are preparing a service development plan for the corridor to guide further development and capital investment in passenger rail improvements identified in the EIS Record of Decision. The Oklahoma Department of Transportation (ODOT) is a partnering state agency for the Study and the EIS.

The 850-mile corridor analyzed for the Study runs north-south and roughly parallels Interstate Highway 35 (IH-35), with the northern point in Edmond, Oklahoma (i.e., northern end of the Oklahoma City portion of the corridor), and the southern end in south Texas, potentially in Corpus Christi, Brownsville, Laredo, or the Rio Grande Valley, as shown on Figure 1-1. For this service-level analysis, a preliminary alignment was developed to represent each EIS alternative, based on conceptual engineering that considered and avoided obvious physical or environmental constraints. These alignments were not refined to optimize performance, reduce cost, avoid specific properties or individual environmental resources, or for any other such considerations. If an alternative is selected at the service-level for further development, the above considerations would be assessed at the project level. For the service-level EIS, a broad corridor of study with a width of 500 feet has been identified along each route for most environmental resources being analyzed.[1] The 500 foot-wide EIS Study Area corridor provides an envelope that could accommodate areas for associated effects, including necessary roadway shifts, grade separations, construction activities, and affiliated features such as stations and parking, traction-power substations, power lines, and maintenance-of-way facilities. This corridor is composed of areas 500 feet on either side of the preliminary alignment and is the area used to identify aesthetic and visual resources that could be potentially affected by the build alternatives. Typically, county-wide data were collected for counties partially or completely within the Study Area.

The analysis provides quantitative information about air quality within the EIS Study Area for each alternative and compares it against the No Build Alternative and other build alternatives in the same geographic region. The discussion of effects also provides qualitative differences in

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[1] Other environmental resource issues, such as transportation, air quality, and noise and vibration, also use broader study areas to determine impacts.

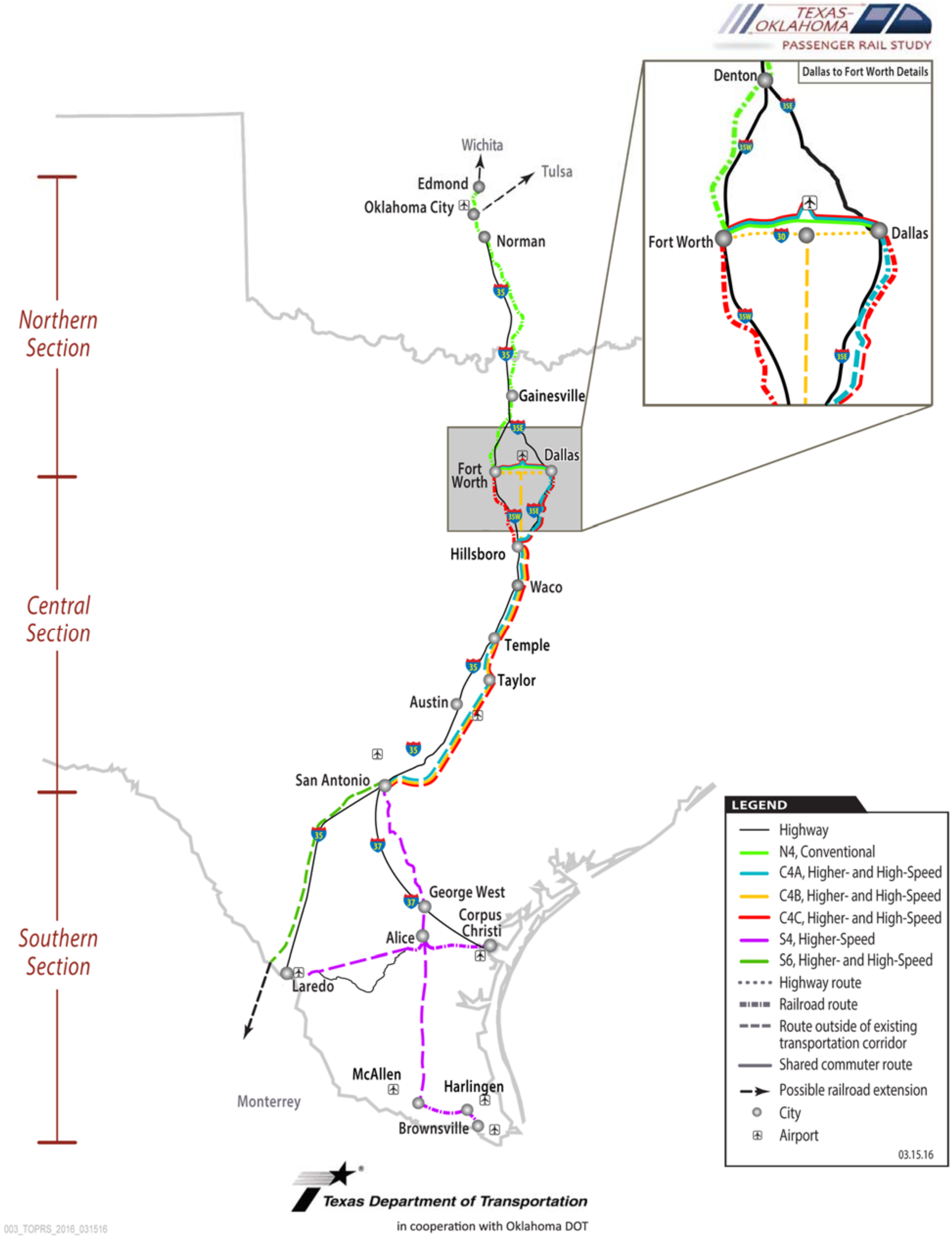

Figure 1-1: Build Alternatives

permanent, temporary, and direct and indirect effects that are associated with the service type (conventional rail, higher-speed rail, or high-speed rail) relative to the environmental context. However, because the 500-foot EIS Study Area does not represent the actual footprint of operation or construction phases, the analysis is primarily comparative, based on the presence of the resources within the EIS Study Area and the likelihood of effects as appropriate for this service-level analysis.

The build alternatives are divided into the following three geographic sections based on the key regional markets that could be served by passenger rail improvements:

- Northern Section: Oklahoma City to Dallas and Fort Worth
- Central Section: Dallas and Fort Worth to San Antonio
- Southern Section: San Antonio to South Texas

In addition, the alternatives consist of both a route, which refers to the specific corridor that a potential alignment follows, and a service type, which refers to the speed or category of rail transportation (conventional rail, higher-speed rail, or high-speed rail). The alternatives that have been carried forward for analysis in the EIS, including their geographic sections, routes, and service types, are listed in Table 1-1.

Table 1-1: Alternatives Carried Forward for Further Evaluation

Route	Service Type[a]
Northern Section	
N4A	CONV
Central Section	
C4A	HrSR
	HSR
C4B	HrSR
	HSR
C4C	HrSR
	HSR
Southern Section	
S4	HrSR
S6	HrSR
	HSR

[a] CONV = conventional rail (up to 79 to 90 miles per hour [mph]); HrSR = higher-speed rail (up to 110 to 125 mph); HSR = high-speed rail (up to 220 to 250 mph)

The route alternatives were based on the alignments of existing transportation networks with corridors potentially suitable for passenger rail operations[2] (i.e., the existing railroad network and the existing interstate highway network) or they were located on new alignments outside existing transportation corridors. Potential alignments described as “following” railway corridors share existing tracks, are located within an existing right-of-way, or are generally adjacent to existing tracks, depending on the service type. Alternatives that are outside the existing transportation corridor could have greater direct and indirect effects than those located in the existing transportation corridor; for example, alternatives outside existing corridors could divide neighborhoods or wildlife communities or create a potential new barrier.

1.1 Service Type Descriptions

The three service types (conventional rail, higher-speed rail, and high-speed rail) considered in this EIS are described below.

1.1.1 Conventional Rail

Conventional rail typically includes diesel-powered, steel-wheeled trains operating on steel tracks. Roadway crossings may be grade-separated depending on the type of roadway and amount of traffic, and rail rights-of-way may be fenced. Conventional rail would be operated at speeds up to 79 to 90 miles per hour (mph) and would mostly use existing railroad rights-of-way. For conventional rail alternatives, existing railroad track may be used, or in some cases, modifications such as double-tracking could be constructed within the existing right-of-way to accommodate additional trains.

1.1.2 Higher-Speed Rail

Higher-speed rail is similar to conventional rail in several respects. In many cases, higher-speed rail trains can run on the same steel tracks that support conventional rail, but higher speeds can require improvements such as upgrading wooden ties with concrete ties, improving signaling, and upgrading roadway crossings. In this case, higher-speed rail trains are assumed to be diesel-powered. Higher-speed rail would be operated at speeds up to 110 to 125 mph. Where proposed within an existing railroad right-of-way, a shared right-of-way with separate tracks for freight and passenger services would be constructed. Because of its maximum speed and because train frequency would be similar to conventional rail, higher-speed rail could operate on a single track with passing locations and would not require double-tracking. Where higher-speed rail is proposed outside an existing transportation corridor, the new alignment would be designed with curves and other features that could accommodate high-speed rail service if warranted by ridership and

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[2] The term “operations” includes maintenance of the facilities as well.

economically feasible in the future. However, unlike high-speed rail, the design would not include electrification or a full double track, and some grade crossings would remain.

1.1.3 High-Speed Rail

High-speed rail includes electric trains powered by an overhead power supply system. Train sets are steel wheel on steel rail, but are designed to operate at high speeds with an aerodynamic shape, and suspension and braking systems are designed for high-speed travel. High-speed rail would be operated at speeds up to 220 to 250 mph. The entire right-of-way would be fenced and fully grade-separated. The alignment would be electrified and double-tracked. This service type could only reach its maximum speeds outside existing transportation corridors because existing railroad alignments are not compatible with the speeds required and they do not have the required space for separation of freight and high-speed rail. In areas where this service type is within existing transportation corridors, it would operate at lower speeds.

1.2 Alternative Descriptions

For this service-level analysis, a preliminary alignment was developed to represent each route alternative, based on conceptual engineering that considered obvious physical or environmental constraints. They are not detailed alignments that have been refined to optimize performance, reduce cost, avoid specific properties or individual environmental resources, or similar considerations, which would be assessed at the project-level phase for alternatives carried forward for further analysis.

The alternatives evaluated in the service-level EIS, shown on Figure 1-1, have been developed to a level of detail appropriate for a service-level analysis: the route alternatives represent a potential corridor where rail improvements could be implemented but do not specify the precise location of the track alignment. When a route is refined to include a service type (conventional, higher-speed, or high-speed rail), it is then referred to as an alternative. Alternatives in the Northern, Central, and Southern sections could be built as individual, stand-alone projects or in combination with alternatives in another section. In addition, more than one alternative in the Central Section and Southern Section could be built in the future because the alternatives provide different service types for independent destinations. Details on connecting the alternatives would be determined during project-level studies.

Potential alignments are described below in terms of nearby transportation corridors and cities.

The Southern Section alternatives include a potential extension to Monterrey, Mexico. The EIS evaluates alignment corridors only within the United States; however, the potential extension to Monterrey has been included for ridership analysis purposes, and FRA and TxDOT have initiated coordination with the Mexican government about the potential extension.

1.2.1 No Build Alternative

The No Build Alternative would not fulfill the Program’s purpose and need but is carried forward as a baseline alternative against which the build alternatives are compared. The No Build Alternative would consist of the existing transportation network, including roadway, passenger rail, and air travel in the Study Vicinity and committed improvements to these systems. The No Build Alternative includes existing and planned roadway, passenger rail, and air travel in the Study Vicinity (including operation, maintenance, and expansion). Information was collected from current regional transportation plans within the Study Vicinity and websites describing services such as train schedules. These improvements and their evaluation at this service-level stage would require project-specific assessment.

1.2.2 Northern Section: Oklahoma City to Dallas and Fort Worth

Due to feasibility based on initial ridership and cost information, only one route alternative with one service type was considered feasible in the Northern Section: Alternative N4A with conventional rail.

1.2.2.1 Alternative N4A Conventional Rail

Alternative N4A would begin in Edmond, Oklahoma, and follow the BNSF rail alignment south to Oklahoma City. The alternative would continue south along the BNSF rail alignment to Norman, Oklahoma; through Metro Junction, near Denton, Texas; and on to Fort Worth (as does the Heartland Flyer). From Fort Worth, the alternative would continue east to Dallas following the Trinity Railway Express (TRE) tracks. From Edmond to Dallas, the route would be approximately 260 miles long. Because existing freight traffic would not preclude passenger service along this section of track, the route would provide passenger rail service on the existing BNSF track, with potential improvements within the existing BNSF right-of-way.

Alternative N4A would provide several improvements over the existing Heartland Flyer service. Alternative N4A would increase the number of daily round trips along this route (the Heartland Flyer currently offers one round trip per day), and the N4A route would extend from Fort Worth to Dallas without requiring a transfer (the Heartland Flyer service currently terminates in Fort Worth). In addition, Alternative N4A would provide improvements to existing station facilities and new train equipment with more onboard amenities, including business class available for a premium price.

Alternative N4A assumes diesel-locomotive hauled equipment running three to six daily round trips. Two or three of the round trips would operate on an accelerated schedule, making roughly seven stops, with the remaining local trains making up to 12 stops.

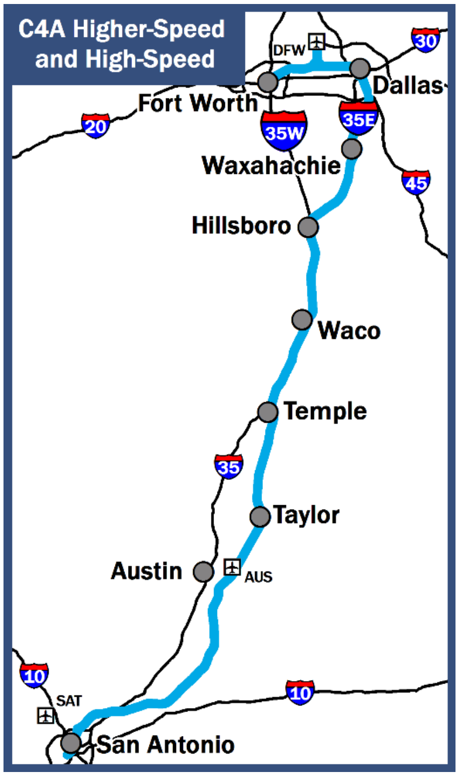
1.2.3 Central Section: Dallas and Fort Worth to San Antonio

Three route alternatives, each with higher-speed and high-speed rail options, were evaluated in the Central Section: Alternatives C4A, C4B, and C4C.

The Central Section alternatives would provide several improvements over the existing Texas Eagle service in this corridor. All of the alternatives would increase the number of daily round trips along this route (the Texas Eagle currently offers one round trip per day), The high-speed rail options would provide faster service between Dallas and Fort Worth and Antonio — 2 hours versus 8 hours for the Texas Eagle Service. In addition, the Central Section alternatives would provide improvements to existing station facilities and new train equipment.

1.2.3.1 Alternative C4A Higher-Speed and High-Speed Rail

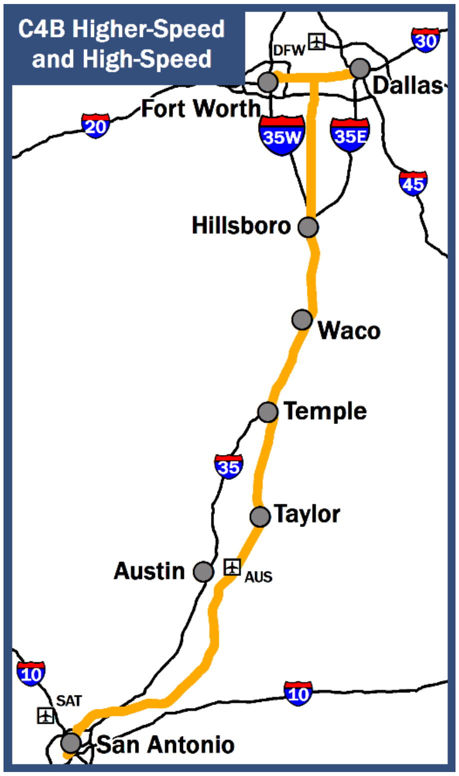
Alternative C4A would begin in Fort Worth and follow the TRE tracks east to Dallas. From Dallas, it would follow the BNSF alignment south toward Waxahachie where it would enter a new alignment outside existing highway and rail corridors to accommodate maximum operating speeds. Though outside existing transportation corridors, the southern portion of Alternative C4A would generally follow the BNSF alignment for about 250 miles, traveling south from Waxahachie through Hillsboro, Waco, Temple, Taylor, and Austin to San Antonio.



Alternative C4A Higher-Speed Rail assumes new high-performance diesel-locomotive hauled equipment running six to 12 daily round trips. Express trains would likely make seven stops, and local trains would make up to 12 stops.

Alternative C4A High-Speed Rail assumes true electric-powered, high-speed service running 12 to 20 daily round trips. Express trains would likely make six stops, and local trains would make up to nine stops.

1.2.3.2 Alternative C4B Higher-Speed and High-Speed Rail

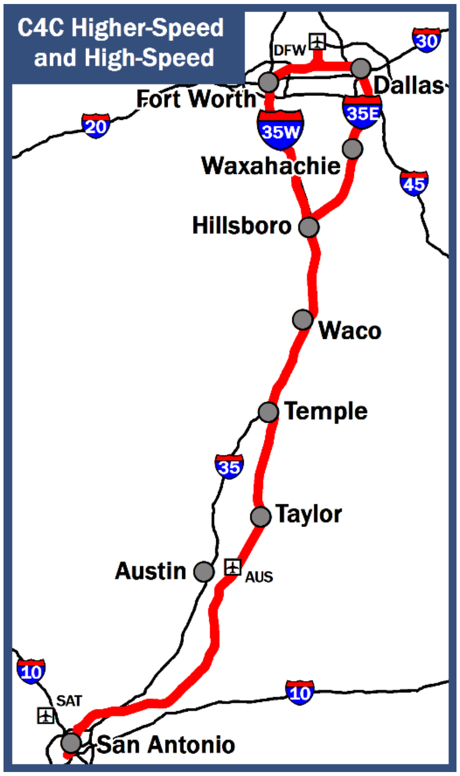


Alternative C4B would serve both Fort Worth and Dallas, with trains following a new elevated high-speed rail alignment over IH-30. In Arlington (between Dallas and Fort Worth), the alternative would turn south to Hillsboro on an alignment outside existing transportation corridors. The alternative would then follow the same high-speed rail alignment as Alternative C4A from Hillsboro to San Antonio.

Alternative C4B Higher-Speed Rail assumes new high-performance diesel-locomotive hauled equipment running six to 12 daily round trips. Express trains would likely make seven stops, and local trains would make up to 12 stops.

Alternative C4B High-Speed Rail assumes true electric-powered, high-speed service running 12 to 20 daily round trips. Express trains would likely make six stops, and local trains would make up to eight stops.

1.2.3.3 Alternative C4C Higher-Speed and High-Speed Rail



Alternative C4C would follow the same potential alignment as Alternative C4A from Fort Worth east to Dallas and south to San Antonio, but would include a link from Hillsboro directly to Fort Worth parallel to the UPRR alignment. Service on the Alternative C4C route would operate in a clockwise direction, running from Hillsboro to Fort Worth, to Dallas, back to Hillsboro, and south to San Antonio in order to serve Fort Worth directly (while also being compatible with the general service for Alternative C4A).

Alternative C4C Higher-Speed Rail assumes new high-performance diesel-locomotive hauled equipment running six to 12 daily round trips. Express trains would likely make seven stops, and local trains would make up to 12 stops.

Alternative C4C High-Speed Rail assumes true electric-powered high-speed service running 12 to 20 daily round trips. Express trains would likely make six stops, and local trains would make up to nine stops.

1.2.4 Southern Section: San Antonio to South Texas

Two route alternatives were evaluated in the Southern Section: Alternative S4, with higher-speed rail, and Alternative S6, with higher-speed and high-speed rail options.

1.2.4.1 Alternative S4 Higher-Speed Rail

Alternative S4 Higher-Speed Rail would begin in San Antonio and travel southeast along the UPRR alignment to George West, where it would continue outside existing transportation corridors to Alice. At Alice, the alternative would divide into three legs at a stop. The first leg would travel west along the Kansas City Southern (KCS) Railway to San Diego, Texas; it would then travel outside existing transportation corridors to east of Laredo in an alignment that would allow higher speeds and rejoin the KCS Railway to enter the highly developed Laredo area. The second leg would travel south along abandoned railroad tracks to McAllen and east to Harlingen and Brownsville. The third leg would travel east along the KCS Railway to Corpus Christi.

Alternative S4 Higher-Speed Rail assumes new high-performance diesel-locomotive hauled equipment running four to six daily round trips. Depending on corridor demand model forecasts, the primary service may be designated as Laredo-Alice-San Antonio and Corpus Christie-Alice-San Antonio, with a connecting feeder from Brownsville, Harlingen, and McAllen.

1.2.4.2 Alternative S6 Higher-Speed and High-Speed Rail

Alternative S6 would begin in San Antonio and travel south on a new alignment outside existing transportation corridors to a station near the Laredo-Columbia Solidarity Bridge, which crosses the Rio Grande north of Laredo. The alternative would then cross on a new railway bridge to join a new rail line being constructed in Mexico, which would continue to Monterrey. This study only examines the physical effects of the U.S. component of this new line, but it does consider the ridership effect of such a connection.

Alternative S6 Higher-Speed Rail assumes new high-performance diesel-locomotive hauled equipment running four to six daily round trips between San Antonio and Laredo, which would be the only U.S. stops for the alternative. If an extension from Laredo to Monterrey is added, the frequency of trips to Monterrey is assumed to be the same as those from San Antonio to Laredo.

Alternative S6 High-Speed Rail assumes true electric-powered, high-speed service running eight to 12 daily round trips between San Antonio and Laredo. If an extension from Laredo to Monterrey is added, the frequency of trips to Monterrey is assumed to be the same as those from San Antonio to Laredo.

1.2.5 Station Cities

The study does not evaluate specific station locations, and no conclusion about the exact location of stations will be made as part of the service-level EIS process. However, based on ridership data and transit connectivity information developed as part of the Alternatives Analysis (TxDOT 2014), and based on stakeholder input, the cities in which stations would most likely be located have been assumed. The size and design of stations would be appropriate for the service type and the route of the alternative. Cities that could have stations are listed in Table 1-2.

Table 1-2: Cities with Potential Stations

Oklahoma	
Edmond	Pauls Valley
Oklahoma City	Ardmore
Norman	
Texas	
Gainesville	Austin
Fort Worth	San Antonio
Arlington	Alice
Dallas	Corpus Christi
Waxahachie	Harlingen
Waco	McAllen
Temple (also serving Killeen)	Brownsville
Taylor	Laredo

2.0 Regulatory Context and Purpose

The purpose of this air quality technical study is to provide an overview of the meteorological conditions and existing monitored air quality conditions in which the proposed project traverses, including conformance with ambient air quality standards (AAQS). In addition, this section describes the potential impacts resulting from each project alternative during construction and operation that may directly and indirectly affect state and regional air quality under the alternatives, using the existing and No Build conditions for comparison.

2.1 Air Pollutants

Air quality describes the level of pollution in the air. Air pollutants, individually and in combination, degrade the atmosphere by reducing visibility, damaging property, reducing the productivity or vigor of crops or natural vegetation, or harming human or animal health.

The U.S. Environmental Protection Agency (EPA) has established National Ambient Air Quality Standards (NAAQS) for the following major air pollutants. These pollutants, known as criteria pollutants, are carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxides (NO_2), ozone (O_3), particulate matter 10 micrometers or less in diameter (PM_{10}) and particulate matter 2.5 micrometers or less in diameter ($PM_{2.5}$), and lead (Pb) (EPA 2016a). CO is a colorless, odorless gas that is generated in the urban environment primarily by the incomplete combustion of fossil fuels in motor vehicles. Relatively high concentrations of CO can be found near crowded intersections and along heavily used roadways carrying slow-moving traffic. CO chemically combines with the hemoglobin in red blood cells to decrease the oxygen-carrying capacity of the blood. Prolonged exposure can cause headaches, drowsiness, or loss of equilibrium.

SO_2 could be generated by the incomplete combustion of fossil fuels in motor vehicles. However, relatively little SO_2 is emitted from motor vehicles. The health effects of SO_2 include respiratory illness, damage to the respiratory tract, and bronchio-constriction.

NO_2 and nitrogen oxide (NO), collectively referred to as NO_x, are major contributors to ozone formation. NO_x could be emitted by motor vehicles. Although NO_2 and NO can irritate the eyes and nose and impair the respiratory system, NO_x is of concern primarily because of its role in the formation of ozone.

Ozone is a photochemical oxidant that is a major cause of lung and eye irritation in urban environments. It is formed through a series of reactions involving VOC and NO_x that take place in the atmosphere in the presence of sunlight. Relatively high concentrations of ozone are normally found only in the summer because low wind speeds of stagnant air coupled with warm temperatures and cloudless skies provide the optimum conditions for ozone formation. Because of the long reaction time involved, peak ozone concentrations often occur far downwind of the precursor emissions. Thus, ozone is considered a regional pollutant rather than a localized pollutant.

Particulate matter includes both airborne and deposited particles of a wide range of size and composition. Of particular concern for air quality are PM_{10} and $PM_{2.5}$. The data collected through many nationwide studies indicate that most PM_{10} is product of fugitive dust, wind erosion, and agricultural and forestry sources, while a small portion is produced by fuel combustion processes. However, combustion of fossil fuels account for a significant portion of $PM_{2.5}$. Airborne particulate matter mainly affects the respiratory system.

Lead is a stable chemical element that persists and accumulates both in the environment and in humans and animals. There are many sources of lead pollution, including mobile sources such as motor vehicles and other gasoline-powered engines, and non-mobile sources such as petroleum refineries. Lead levels in the urban environment from mobile sources have significantly decreased due to the federally mandated switch to lead-free gasoline. The principal effects of lead on humans are on the blood-forming, nervous, and renal systems.

The criteria pollutants of concern for transportation-related sources include PM_{10} and $PM_{2.5}$ due to diesel locomotive emissions (referred to as diesel particulates), CO and NO_x due to roadway vehicle emissions, and ozone. Ozone is formed through photochemical reactions between precursor gases including volatile organic compounds (VOCs) and NO_x. Sources of VOCs and NO_x include emissions from internal combustion engines such as roadway vehicles and diesel locomotives.

Carbon dioxide (CO_2) is a colorless, odorless gas that occurs naturally in the earth's atmosphere. Significant quantities are also emitted into the air by fossil fuel combustion. CO_2 is considered a greenhouse gas (GHG). The natural greenhouse effect allows the earth to remain warm and sustain life. GHGs trap the sun's heat in the atmosphere and help determine our climate. As atmospheric concentrations of GHGs rise, so may temperatures. Higher temperatures may result in more emissions, increased smog, and respiratory disease.

GHGs are also pollutants of concern. These gases trap heat in the atmosphere and are necessary to life as we know it because they keep the planet's surface warm. As concentrations of GHG increase, however, the Earth's temperature rises. This is known as the "Greenhouse Gas Effect." Effects of these rising temperatures include climate change and rising sea levels. With respect to transportation-related sources, such as the diesel trains and personal vehicles of this proposed project, and other fossil fuel combustion sources, the GHG of primary concern is CO_2. Other GHGs of concern include methane, NO_x and certain fluorinated gases.

In addition to the criteria and GHG pollutants, EPA also regulates air toxics. Mobile source air toxics (MSATs) are compounds emitted from highway vehicles and non-road equipment that are known or suspected to cause cancer or other serious health and environmental effects. Most air toxics originate from human made sources, including on-road mobile sources, non-road mobile sources (e.g., trains), area sources (e.g., dry cleaners), and stationary sources (e.g., factories or refineries).

2.2 Regulatory Requirements (Laws, Regulations, and Orders)

Air quality is regulated at the federal level by EPA and at the state level by the Texas Commission on Environmental Quality (TCEQ) and the Oklahoma Department of Environmental Quality (ODEQ). The following section describes the federal and state regulations that are applicable to the proposed project.

2.2.1 Federal

Clean Air Act and National Ambient Air Quality Standards

EPA is the federal agency that develops and enforces the regulations that help govern air quality. The federal Clean Air Act of 1970 (CAA) and CAA Amendments of 1990 established the NAAQS for specific criteria pollutants in 40 Code of Federal Regulations (CFR) Part 50 to protect public health. The primary standards are intended to protect the public health with an adequate margin of safety. The secondary standards are intended to protect the nation's welfare and account for air-pollutant impacts on soil, water, visibility, vegetation, and other aspects of the general welfare. The primary and secondary NAAQS exist for the six criteria pollutants: CO, SO_2, NO_2, O_3, PM_{10} and $PM_{2.5}$, and Pb. The NAAQS for criteria pollutants are shown in Table 2-1 (EPA 2016a). ODEQ and TCEQ have adopted the NAAQS as their state standards (ODEQ 2013a; TCEQ 2014a).

Table 2-1: Ambient Air Quality Standards for Criteria Pollutants

Pollutant	Primary / Secondary	Concentration Averaging Time	NAAQS	Threshold
Carbon Monoxide (CO)	Primary	8-hour	9 ppm	Not to be exceeded more than once per year
		1-hour	35 ppm	
Lead (Pb)	Primary and Secondary	Rolling 3 month average[a]	0.15 μg/m³	Not to be exceeded
Nitrogen Dioxide (NO_2)	Primary	1-hour[b]	100 ppb	98th percentile, averaged over 3 years
	Primary and Secondary	Annual[c]	53 ppb	Annual Mean
Ozone (O_3)	Primary and Secondary	8-hour (2015 Standard)[d]	0.070 ppm	Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years

Pollutant	Primary / Secondary	Concentration Averaging Time	NAAQS	Threshold
Particulate Matter ($PM_{2.5}$)	Primary	Annual	12 $\mu g/m^3$	weighted annual mean, averaged over 3 years
	Secondary	Annual	15 $\mu g/m^3$	annual mean, averaged over 3 years
	Primary and Secondary	24-hour	35 $\mu g/m^3$	98th percentile, averaged over 3 years
Particulate Matter (PM_{10})	Primary and Secondary	24-hour	150 $\mu g/m^3$	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide (SO_2)	Primary	1-hour	75 ppb[e]	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
	Secondary	3-hour	0.5 ppm	Not to be exceeded more than once per year

[a] Final rule signed October 15, 2008. The 1978 lead standard (1.5 µg/m3 as a quarterly average) remains in effect until one year after an area is designated for the 2008 standard, except that in areas designated nonattainment for the 1978, the 1978 standard remains in effect until implementation plans to attain or maintain the 2008 standard are approved.

[b] To attain this standard, the 3-year average of the 98th percentile of the daily maximum 1-hour average at each monitor within an area must not exceed 100 ppb

[c] The official level of the annual NO_2 standard is 0.053 ppm, equal to 53 ppb, which is shown here for the purpose of clearer comparison to the 1-hour standard.

[d] Final rule signed October 26, 2015.

[e] Final rule signed June 2, 2010. The 1971 annual and 24-hour SO_2 standards were revoked in that same rulemaking. However, these standards remain in effect until one year after an area is designated for the 2010 standard, except in areas designated nonattainment for the 1971 standards, where the 1971 standards remain in effect until implementation plans to attain or maintain the 2010 standard are approved.

$\mu g/m^3$ = micrograms per cubic meter

ppb = parts per billion

ppm = parts per million

Source: EPA (2016a).

The CAA requires EPA to classify areas in the country as attainment or nonattainment, with respect to each criteria pollutant, depending on whether the areas meet the applicable NAAQS. Areas classified as "attainment areas" comply with the applicable NAAQS. Areas once classified as nonattainment that have since demonstrated attainment of the NAAQS are classified as "maintenance areas." Maintenance areas are required to implement the EPA-approved maintenance plan to maintain the standard under NAAQS. Areas not in compliance with the NAAQS are classified as "nonattainment areas."

The CAA requires each state to produce and regularly update a state implementation plan (SIP) for each criteria pollutant that violates the applicable NAAQS. SIP is an enforceable plan developed at the state level that serves as a tool to avoid and minimize emissions of pollutants to achieve compliance with the NAAQS.

General Conformity

The EPA Conformity Rule requires federal agencies to ensure that any federal action resulting in emissions of any nonattainment or maintenance criteria pollutants conforms with the approved or promulgated state or federal implementation plans for attaining or maintaining the NAAQS. Specifically, this means ensuring that the federal action will not (1) cause a new violation of NAAQS, (2) increase the frequency or severity of existing violations of NAAQS, or (3) delay the timely attainment of NAAQS interim or other attainment milestones. The EPA Final Conformity Rule applies only to federal actions in NAAQS nonattainment or maintenance areas.

National Environmental Policy Act

Signed into law on January 1, 1970, the National Environmental Policy Act (NEPA) requires federal agencies to assess the environmental effects of their proposed actions prior to making decisions. In 1978, the Council on Environmental Quality (CEQ) issued regulations (40 CFR Parts 1500-1508) to implement NEPA. These regulations are binding on all federal agencies. The regulations address the procedural provisions of NEPA and the administration of the NEPA process, including the preparation of environmental assessments and EIS documents to assess the likelihood of impacts from alternative courses of action.

Air Toxics

In addition to the criteria pollutants, EPA also regulates air toxic emissions. Controlling air toxic emissions became a national priority with the passage of the CAA Amendments of 1990, whereby Congress mandated that EPA regulates 188 air toxics, also known as hazardous air pollutants. EPA has assessed this expansive list in its latest rule on the Control of Hazardous Air Pollutants from Mobile Sources (Federal Register, Vol. 72, No. 37, page 8430, February 26, 2007) and identified a group of 93 compounds emitted from mobile sources that are listed in its Integrated Risk Information System (http://www.epa.gov/iris/). In addition, EPA identified seven compounds with significant contributions from mobile sources that are among the national and regional-scale cancer risk drivers from its 1999 National Air Toxics Assessment (http://www.epa.gov/ttn/atw/nata1999/); these compounds are acrolein, benzene, 1,3-butidiene, diesel particulate matter plus diesel exhaust organic gases (diesel PM), formaldehyde, naphthalene, and polycyclic organic matter. While EPA has regulations to limit the emissions of air toxics, there are currently no federal or state ambient air quality concentration standards for air toxics

Greenhouse Gases

In addition to regulating criteria pollutants, in accordance with the CAA Section 202(a) and the Final Endangerment and Cause or Contribute Findings, GHG pollutants are also regulated at the federal level (EPA 2014). CEQ released revised draft guidance on the consideration of GHG in NEPA documents for all federal actions on December 18, 2014. The revised guidance established a reference point of 25,000 metric tons of CO_2-e emissions on an annual basis, below which a quantitative GHG emissions analysis is not warranted (CEQ 2014). The draft CEQ guidance is still under review, and currently there is not a quantitative federal threshold to address GHG emissions and the impacts on climate change at the project level.

CO_2 is the largest component of these GHG emissions. Historically, GHG emissions have not been regulated under the CAA as air pollutants. However, after the U.S. Supreme Court in 2007 clarified that CO_2 is an "air pollutant" subject to regulation under the CAA, EPA embarked on developing requirements and standards for GHG emissions from mobile and stationary sources under the CAA. However, currently there are no NAAQS or *de minimis* thresholds in place for GHG. The following summarizes the main GHG regulatory initiatives recently undertaken by EPA in the transportation sector.

- EPA and the National Highway Traffic Safety Administration are taking steps to enable the production of a new generation of clean vehicles, through the reduction of GHG emissions and improved fuel use. Together, the enacted and proposed standards are expected to save more than six billion barrels of oil through 2025 and reduce more than 3,100 million metric tons of CO_2 emissions (EPA 2016b).
- EPA is also responsible for developing and implementing regulations to ensure that transportation fuel sold in the United States contains a minimum volume of renewable fuel. By 2022, the Renewable Fuel Standard Program, which was created under the Energy Policy Act of 2005, anticipates reducing GHG emissions by 138 million metric tons, equivalent to the annual emissions of 27 million passenger vehicles (EPA 2016b).

GHGs are addressed on a regional or national level. Although no ambient air quality standards have been established for GHGs, the federal government has established a goal of reducing GHG emissions from transportation related activities. The goal will be attained by implementing the following four strategies:

1. Use low carbon fuels including but not limited to ethanol, biodiesel, natural gas, liquefied petroleum gas, synthetic fuels, hydrogen, and electricity;
2. Increase vehicle fuel efficiency by developing and bringing to market advanced engine and transmission designs, lighter-weight materials, improved vehicle aerodynamics, and reduced rolling resistance, which would result in lower fuel use (U.S. Department of Transportation [USDOT] 2010);
3. Improve transportation system efficiency through traffic management and bottleneck relief as well as lowering speed limits on national highways;
4. Reduce carbon intensive transit activity by implementing transportation pricing strategies, a few examples being a fee per vehicle-mile traveled (VMT) of about 5 cents per mile, an increase in the motor fuel tax of about $1.00 per gallon, or pay-as-you-drive insurance. Also significant expansion of urban transit services, in conjunction with land use changes and pedestrian and bicycle improvements would be included (USDOT 2010).

To date, no national standards have been established regarding GHGs, nor has EPA established criteria or thresholds for ambient GHG emissions pursuant to its authority to establish motor vehicle emission standards for CO_2 under the CAA. However, there is a considerable body of scientific literature addressing the sources of GHG emissions and their impacts on climate, including reports from the Intergovernmental Panel on Climate Change, the National Academy of Sciences, EPA, and other federal agencies. Given their characteristic rapid dispersion into the global atmosphere, GHGs are different from other air pollutants evaluated in federal environmental reviews because the impacts are not localized or regional. From a quantitative perspective and in terms of both absolute numbers and types, global climate change is the cumulative result of numerous and varied natural and anthropogenic emissions sources. Each source makes a relatively small addition to global atmospheric GHG concentrations. In contrast to broad-scale actions such as those involving an entire industry sector or very large geographic areas, it is difficult to isolate and understand the GHG emissions impacts for a particular transportation project (TxDOT 2015).

2.2.2 State Regulations

2.2.2.1 Oklahoma

Air quality is regulated at the state level by the ODEQ as specified by the Oklahoma Administrative Code (OAC) Title 252 Chapter 100. Oklahoma has a Regional Haze Implementation Plan consistent with federal Prevention of Significant Deterioration regulations to protect the state’s one Class 1 area, the Wichita Mountains, which are located 60 to 90 miles west of the proposed project area (ODEQ 2013b). Oklahoma does not have any areas classified as nonattainment or maintenance areas according to the NAAQS.

As previously mentioned, ODEQ has adopted the NAAQS as its state standards for the criteria pollutants, which are shown in Table 2-1 (ODEQ 2013a). Oklahoma does not have any areas classified as being in nonattainment or maintenance in respect to the NAAQS and uses its stationary new source review and permitting programs as the foundation of its SIP which is approved by the governor in order to maintain compliance with the NAAQS (ODEQ 2014). Although all regions of Oklahoma are in attainment or unclassified with the NAAQS, the Association of Central Oklahoma Governments (ACOG) participated in the EPA 8-Hour Ozone Flex program to implement voluntary reduction measures to control ground level ozone formation and set a 5-year plan in place for Central Oklahoma in June 2008 (40 CFR Part 81 Subpart C Section 107). Activities associated with the 5-year plan concluded in June 2013. In 2012, ACOG registered with EPA for participation in EPA's Ozone Advance Program where participants have agreed to take proactive steps toward improving air quality (ACOG 2012). Programs that are being implemented as a part of ACOG's advance voluntary program are the Oklahoma City metro area's Compressed Natural Gas and Alternative Fuels Programs (EPA 2013).

Oklahoma currently has two SIP plan revisions pending submission to EPA in regards to the NAAQS 2008 primary and secondary 8-hour ozone standards and the 2010 primary SO_2 standard (ODEQ 2014). Oklahoma's Interstate Transport SIP for an Assessment of Oklahoma's Impact on Downwind Nonattainment for the National Ambient 8-hour Ozone and $PM_{2.5}$ Air Quality Standards, submitted to EPA in May 2007 (including supplemental information submitted in November 2007), demonstrates that Oklahoma does not have a significant impact on ozone or $PM_{2.5}$ nonattainment for any other state, nor interfere with maintenance of the NAAQS in any other state (ODEQ 2013b). Oklahoma also maintains a Regional Haze Implementation Plan that was last revised and submitted to EPA on June 18, 2013. The Regional Haze Implementation Plan addresses Best Achievable Retrofit Technologies (BART) to address emissions of NO_2, SO_2 and particulate matter (PM) at three power plants (six total coal-fired units). This plan should not affect the project (ODEQ 2013c).

2.2.2.2 Texas

Air quality is regulated at the state level by TCEQ under Texas Administrative Code (TAC) Title 30 Part 1 Chapters 101 through 122 (TCEQ 2013a). Texas has several areas, especially in Dallas and Fort Worth that are nonattainment for one or more NAAQS.

Texas has developed a SIP to manage emissions on a state-wide and regional basis. Revisions to the SIP incorporate changes in regulations and attainment status of regions. The most recent state wide revision was the Regional Haze update, which was approved by EPA in March 2014. The 2014 Five-Year Regional Haze SIP Revision implements further reductions in the NO_X emissions caps for electricity generating units that go into place in 2015, and continues with clean diesel and motor vehicle programs as the primary method to address the 1997 8-hour ozone standard. A new attainment deadline has not yet been issued (TCEQ 2014b). The motor vehicle and fuel programs that are implemented by the state of Texas will reduce statewide air pollutant emissions. These programs include the Texas Emissions Reduction Plan (TERP), the Vehicle Inspection and Maintenance (I/M) Program (TCEQ 2014c), and the Texas Low Emission Diesel Fuel Program initially implemented in 2005 (TCEQ 2014d).

Texas has also adopted SIP revisions that affect only portions of the state. These revisions affecting the proposed project areas include the ozone and lead planning activities for the Dallas and Fort Worth area, which predominantly target stationary sources in the region; and the Austin-Round Rock, San Antonio, and Corpus Christi area ozone planning activities (TCEQ 2014a).

Details of attainment status of Texas are summarized in Table 3-1, in Section 3.0, Affected Environment. The Dallas and Fort Worth counties of Denton, Tarrant, Dallas, Johnson, and Ellis are designated as moderate nonattainment areas for the 2008 8-hour ozone standard, and serious nonattainment for the 1997 8-hour ozone standard. To show progress towards attainment of the 1997 8-hour ozone standard on July 2, 2014, TCEQ adopted the Attainment Demonstration SIP Revision that includes the Dallas and Fort Worth area, a Reasonable Further Progress SIP Revision, and revisions to 30 TAC, Chapter 115 into the Texas SIP. EPA approval of these revisions is pending (TCEQ 2014e). A portion of Collin County is nonattainment for the 2008 lead standard, and a maintenance area for the 1978 lead standard (TCEQ 2013b).

Areas designated as attainment or unclassified/attainment for the 8-hour ozone standard, as published on April 30, 2004 (69 Federal Register 23858) are eligible to participate in EPA's 8-Hour Ozone Flex program. The program is implemented through a voluntary intergovernmental agreement (Memorandum of Agreement [MOA]) among EPA, TCEQ, and the local communities. The proposed project travels through the city of Austin, which is a participant in the MOA (EPA 2008). The Austin-Round Rock Eight-Hour Ozone Flex MOA commits the Austin-Round Rock area to continuing the implementation of the Early Action Compact SIP and voluntary emission reduction measures. The MOA also includes applying for TERP grants, when available; Transportation Emission Reduction Measures; regional rideshare program; inviting five or more additional cities to join the area's Clean Air Coalition and becoming signatories to the MOA; implementing a watch/warning ozone alert system for the area; implementing AirCheck Texas local initiative projects with Low Income Repair Assistance Program funds; and road paving projects.

For all pollutants, the counties the project traverses in the Southern Section, including San Antonio, are in attainment or unclassified (TCEQ 2014a). Corpus Christi was designated as attainment by EPA for the 1997 8-hour ozone NAAQS. A five-year agreement was signed in 2007 for Nueces and San Patricio Counties to participate in the Ozone Flex program for the 8-hour ozone standard, which encourages 8-hour ozone attainment areas nationwide to reduce ozone emissions to continue to meet the NAAQS for ozone (EPA 2008; TCEQ 2014a).

3.0 Affected Environment

3.1 Study Area

The Study Area for air quality impacts is composed of the regional air basins that the Program corridor would go through. Air quality in nearby air basins could also be affected by changes in travel patterns, VMTs, and regional pollutant transport resulting from the alternatives, but likely at a much lower level than in the Program corridor. For this service-level analysis, potential effects on air quality are evaluated only for the air basins (i.e., regions) that physically contain the alternatives. The origination point of the proposed project in the north is Edmond, Oklahoma, just north of Oklahoma City, and a termination point in south Texas, potentially in the cities of Laredo or Corpus Christi or the Rio Grande Valley region. Major metropolitan areas are typically the main source of air emissions due to large human populations and numbers of vehicles on the roadways, and more industry. The proposed project travels through the major metropolitan areas of Oklahoma City, Dallas and Fort Worth, Austin, San Antonio, and Corpus Christi.

3.1.1 Northern Section: Oklahoma City to Dallas and Fort Worth

The Northern Section of the proposed project begins in Edmond, Oklahoma, travels through Oklahoma City and southern Oklahoma across the Texas border, through north central Texas, and into the Dallas and Fort Worth area.

While in central Oklahoma the project is located in the Central Oklahoma Intrastate Air Quality Control Region. The largest and most populated metropolitan area in this region is Oklahoma City with a relatively flat topography with elevations around 1,200 feet above sea level situated on the Canadian River. The climate is influenced by the Great Plains and is characterized by frequent winds with long hot summer seasons and shorter milder winters (Oklahoma Climatological Survey [OCS] 2014).

While all of Oklahoma is in attainment or unclassified for all federally regulated pollutants (40 CFR Part 81 Subpart C Section 107), ACOG has been proactive in its planning to reduce mobile source emissions—cars and trucks—which account for approximately 60 percent of the region’s pollution and is currently implementing plans to increase participation in public fleet conversions, the use of public transportation and ride sharing programs. ACOG is also participating in EPA’s 8-hour Ozone Flex Program to implement voluntary reduction measures to control ground level ozone formation (ACOG 2012; EPA 2008).

From southern Oklahoma to the Texas border, the project travels through the Southeastern Oklahoma Intrastate Air Quality Control Region and the counties of Garvin, Murray, Carter, and Love. Southern Oklahoma, south of Oklahoma City, consists of primarily rural areas and small cities and is characterized by rolling hills and flat lands typical of the Great Plains with elevations ranging from approximately 500 to 1,000 feet above sea level. The climate is similar to that found in central Oklahoma (U.S. Census, 2013; OCS 2014).

From the Texas-Oklahoma border, the proposed alignment travels into north central Texas through Cooke County which consists of primarily rural areas and small cities, and into Denton County where the project enters the Dallas-Fort Worth-Arlington air basin and metropolitan area that is currently designated as nonattainment of ozone. The project travels through Denton, Tarrant, Dallas, Johnson, and Ellis counties. This area is the most populated part of the region, with a combined population of over 6.8 million (U.S. Census 2013). This region of rolling hills varies in elevation from 500 to 800 feet above sea level and is characterized by a humid subtropical climate with hot summers; and a continental climate with generally mild winters (National Climatic Data Center [NCDC] 2014; National Oceanic and Atmospheric Administration [NOAA] 2014a).

3.1.2 Central Section: Dallas and Fort Worth to San Antonio

The Central Section of the proposed project begins in Dallas and Fort Worth, which is discussed above and travels through Austin in central Texas and ends in San Antonio in south Texas.

From the Dallas-Fort Worth-Arlington air basin, the alignment traverses the rural counties of Hill, McLennan, Falls, and Bell, and into the Austin-Round Rock air basin through Williamson, Travis, and Caldwell counties.

As the alignment leaves the Dallas-Fort Worth air basin, it enters the into the Austin-Round Rock air basin, which is in attainment or unclassified for all air pollutants (TCEQ 2014a). Austin has almost 900,000 people and is characterized by a humid subtropical climate with hot summers and relatively mild winters (U.S. Census 2013; NOAA 2014b). Elevations within the city range from 400 feet to 1,000 feet above sea level. The winters have temperatures that fall below freezing an average of 25 days per year, with strong cold fronts that bring sudden drops in temperature. (NCDC 2014; NOAA 2014b).

From the Austin-Round Rock air basin, the proposed project travels along I-35 into the San Antonio air basin, traversing Guadalupe and Bexar counties. The San Antonio air basin was designated as attainment for the 1997 8-hour ozone standard by EPA on April 2, 2008 (Federal Register, Vol. 73, No. 64, pages 17897 to 17901). There are no further SIP requirements for the existing standard as long as the area continues to monitor attainment for the standard. San Antonio is the second most populated city in the State of Texas with about 1.4 million people and is located on the northwest edge of the Gulf Coastal Plain, and thus has a modified subtropical climate (U.S. Census 2013; NOAA 2014c). In the winter the area is influenced by a continental climate, with winds from the north and west, and a modified maritime climate, with south and southeast winds from the Gulf of Mexico. Elevation ranges from 550 to 1000 feet above sea level. Summer temperatures average in the 80s and winter temperatures average in the 50s. Precipitation ranges widely between months and years due to the city's location between a semi-arid area to the west and a much wetter and more humid area to the east (NCDC 2014; NOAA 2014c).

In the region south of the Dallas-Fort Worth air basin to the Austin-Round Rock, and between the Austin-Round Rock air basin and San Antonio air basin area, sources including agricultural dust and soil disturbances are major contributors to air pollution. In the Austin-Round Rock air basin and San Antonio air basin the predominant contributors to air pollution are point sources including power plants and industrial facilities, and mobile emissions combined (both road and non-road) (TCEQ 2014a).

3.1.3 Southern Section: San Antonio to South Texas

The Southern Section of the proposed project begins in San Antonio, as discussed above, and terminates in south Texas, potentially in Laredo, the Texas-Mexico border in the west, or Corpus Christi in the Rio Grande Valley region (Brownsville, Harlingen, and McAllen) in the east.

From the San Antonio air basin, the project could travel southwest through the counties of Bexar, Medina, Frio, La Salle, and Dimmit to the Texas-Mexico border in Webb County, roughly 50 miles northwest of Laredo. Alternatively, it could also travel to the southeast from the San Antonio air basin through the counties of Bexar, Atascosa, Live Oak, and Jim Wells. The route would then split to Laredo in the west through Duval and Webb counties, to the Corpus Christi air basin in the east through Nueces County, and to the Rio Grande Valley region in the southeast through Brooks, Hidalgo, and Cameron counties.

The western portion of southern Texas, is sparsely populated with the exception of Laredo having a population slightly over 248,000 people. The eastern portion of south Texas is also sparsely populated with the exception of the urban area of Corpus Christi having a population of just over 300,000. The southernmost tip of Texas bordered by Mexico and the Gulf of Mexico is sparsely populated with the exception of Brownsville, Harlingen, and McAllen (U.S. Census 2013). The area is characterized by low rolling hills with hardwood scrub. The areas along the coast have a subtropical climate due to its proximity to the Gulf of Mexico; however, the location in a semi-arid region results in lower precipitation than other Gulf coast regions. Humidity is high throughout the year due to the Gulf. Most of the precipitation falls in May and September, and winter is the driest season. However, the hurricane season from June to November can alter the amount of rainfall significantly. August and September are the main hurricane months. Winter temperatures can be warm and summers can be hot and very humid, with an average of 93 percent humidity in the mornings (NCDC 2014).

In the rural regions, outside of the San Antonio air basin and Corpus Christi air basin, the predominant contributors to air pollution are area sources including agricultural dust and soil disturbances. In the San Antonio air basin and Corpus Christi air basin, the predominant contributors to air pollution are point sources including power plants and industrial facilities, and mobile emissions combined (both road and non-road) (TCEQ 2014a).

3.2 Existing Conditions

Table 3-1 summarizes the general climate, existing air quality, attainment status, and major emission sources for each of the regions in the Study Area. Of all these regions, only the Dallas-Fort Worth area is designated as nonattainment for ozone and portions of Collin County is nonattainment for lead (2008 standard) and is in maintenance for the 1978 lead standard. The Dallas-Fort Worth area is in attainment or unclassified for all other pollutants. Other regions of the study area are in attainment or unclassified for all pollutants. Specific details about the air quality plans and activities and the ambient air quality conditions of each region are included in the sections below.

Table 3-1: General Climate and Background Air Quality Conditions

Study Segment	Air Basin (Region)	Counties and Main Cities	Attainment/ nonattainment [a]	Weather / Topography	Main Sources of Air Emissions
Northern Section: Oklahoma City to Dallas-and Fort Worth	Central Oklahoma Intrastate Air Quality Control Region	Oklahoma City; Garvin, Murray, Carter, and Love Counties	Oklahoma: Attainment for all criteria pollutants	Frequent winds, long hot summers and shorter milder winters; [b,c] mostly flat with rolling hills	Power plants, industrial, and mobile sources [j]
	Northern Texas	Cooke County	Attainment		
Central Section: Dallas and-Fort Worth to San Antonio	Dallas-Fort Worth – Arlington Basin	Dallas, Fort Worth, Arlington; Denton, Tarrant, Dallas, Johnson, Ellis, and Collins Counties	Dallas-Fort Worth-Arlington Area: Nonattainment 8-hour ozone Collins County: Nonattainment, lead (2008 standard), Maintenance (1978 standard) Attainment/unclassified for other criteria pollutants	Humid subtropical climate with hot summers; continental climate with generally mild winters; [d] rolling hills	Power plants, industrial, and mobile sources (on-road and off-road) [i]

Study Segment	Air Basin (Region)	Counties and Main Cities	Attainment/ nonattainment [a]	Weather / Topography	Main Sources of Air Emissions
	Austin-Round Rock	Austin, San Antonio; Hill, McLennan, Falls Bell, Williamson, Travis, and Caldwell Counties	Attainment: Unclassified for all criteria pollutants	Humid subtropical climate with hot summers and relatively mild winters but with sudden cold fronts; [e] elevations range from 400 feet to 1,000 feet above sea level	Power plants, industrial, and mobile sources [i]
Southern Section: San Antonio to South Texas	San Antonio	Guadalupe and Bexar Counties	Attainment/ unclassified for all criteria pollutants	Humid subtropical climate with hot summers and relatively mild winters; elevation ranges from 550 to 1,000 feet above sea level [f]	In rural areas, agricultural dust and soil disturbances; In other areas: power plants, industrial, and mobile sources (on-road and off-road) [i]
	Southern Texas	Laredo / Along the Texas-Mexico border; sparsely populated. [g]	Attainment/ unclassified for all criteria pollutants	Semi-arid region results in lower precipitation than other Gulf Coast regions; low, rolling hills.	In rural areas Agricultural dust and soil disturbances; In other areas Power plants, industrial, and mobile sources (on-road and off-road) [i]
		Corpus Christi in the Rio Grande Valley Region	Attainment/ unclassified	Subtropical climate [h]	

Study Segment	Air Basin (Region)	Counties and Main Cities	Attainment/ nonattainment [a]	Weather / Topography	Main Sources of Air Emissions

[a] EPA (2016c).

[b] OCS (2014).

[c] U.S. Census (2013); OCS (2014).

[d] NCDC (2014); NOAA (2014a).

[e] U.S. Census (2013); NOAA (2014b).

[f] NCDC (2014); NOAA (2014c).

[g] U.S. Census (2013).

[h] NCDC (2014).

i. TCEQ (2014a).

j. ODEQ (2013b)

In the 2010 Regional Haze Implementation Plan, the Oklahoma DEQ estimates that by 2018 emissions of SO_2, NO_X and PM_{10} will generally decrease due to MACT and BART programs involving point sources such as power plants while NH_3, VOC and $PM_{2.5}$ emissions are projected to increase due primarily to economic growth factors (ODEQ 2013c). In the 2014 Regional Haze SIP, TCEQ estimates that by 2018 statewide emissions of SO_2 and $PM_{2.5}$ will increase slightly while NO_X and PM_{10} emissions are expected to decrease. Electric power industry emissions, a major source of SO_2 in Texas was analyzed to show a continued downward trend of 99,870 tons over a 7-year period from 2005 to 2011 (TCEQ 2014b).

GHG emissions are not limited to regional boundaries but are global. GHG emissions from transportation have been growing steadily in recent decades. In 2014, GHG emissions in the United States from transportation accounted for about 26 percent of total GHG emissions, making it the second largest contributor of US greenhouse gas emissions after the electricity section. GHG emissions from transportation have increased by 17 percent since 1990 (EPA 2016b). The majority of transportation sector GHG emissions result from fossil fuel combustion. CO_2 is the largest component of these GHG emissions.

4.0 Impact Evaluation Methods

Effects on air quality are classified by the type of pollutant, the area of effect, and the duration of effect. The type of potential regional and/or localized air quality effects and the impact evaluation approach of each type of effect are described in the following sections.

4.1 Types of Effects and Evaluation Approach

Several types of potential effects on air quality were considered for each alternative evaluated. The description of the effects, evaluation approach, and which contributing factors relate to the severity of the effect on air quality are discussed below.

4.1.1 Short-term Construction Effects

Construction effects on air quality are generally short term and are due to the emissions from construction equipment, fugitive dust from ground-level disturbances, on-site materials processing and handling such as concrete plants, and vehicle emissions from increases in local traffic congestion. The potential construction impacts on air quality are evaluated based on the intensity of the construction activities and duration of the construction of the Program and corresponding alternatives. The longer the construction period and the more non-road construction equipment used (such as cranes, bulldozers, heavy duty trucks, and concrete batch plants), the greater the potential for construction effects on air quality.

4.1.2 Long-Term Regional Effects

Long-term regional effects on air quality were evaluated based on both the direct and indirect emissions from operation of the Program. The proposed Program will affect air quality through several modes of transportation. These modes include travel between cities by on-road passenger vehicle travel and buses. It will also affect aircraft travel and electrical demands. To estimate the potential effect on regional emissions, results from regional transportation modeling were used to determine VMTs by mode type. The VMTs account for ridership projections and travel demand needs. Details of the assumptions that went into the air emission evaluation are provided in the following sections. The VMTs by mode type were used with source specific emission factors to determine the regional emissions by mode. Details of the assumptions used for each mode type are described in the subsequent sections.

4.1.2.1 On-Road Vehicles

An on-road vehicle emission analysis was conducted using average daily VMTs at average freeway speeds within the counties of the project area. Emission factors were estimated using EPA's Motor Vehicle Emission Simulator (MOVES) model run in emission factor mode. The MOVES model provides emission factors in grams per mile, which are based on speed, vehicle mix, and analysis year for specific counties. Parameters were set to determine emission factors in each region of the project area for the existing year 2013 and the project year 2035. Three counties were chosen to represent each region of the project, Canadian County, Oklahoma, for the Northern Section; Dallas County, Texas, for the Central Section; and Cameron County for the Southern Section. To determine the overall pollutant concentrations, the estimated VMTs were multiplied by the specific pollutant's emission factors. The traffic model did not project changes in emissions for the intercity bus VMTs among the existing conditions, build alternatives, and No Build Alternative. Emissions for passenger vehicles are provided in Appendix A, Table A-1, and emissions for intercity buses are provided in Appendix A, Table A-2.

4.1.2.2 Airport Emissions

The FRA's Emissions and Dispersion Modeling System (EDMS) was used to estimate airplane emissions. EDMS estimates the emissions generated from a specified number of landing and take-off cycles. Average plane emissions were calculated based on the profile of the aircraft, assumed to be similar to a Boeing 737, series 300 passenger plane. In addition to air travel emissions from ground support equipment were included in this evaluation. The travel demand model values were used to determine the number of airplanes per day in each regional segment area. The existing travel demand modeling does not indicate that there would be a change in air emissions due to the proposed project. Therefore, the number of airplanes per day does not change between the existing, no build, or build scenarios. Emissions for airplanes in each region are provided in Appendix A, Table A-3.

4.1.2.3 Power Generation Emissions

Indirect effects on air quality are effects that are not generated directly from the project but are still a result of the proposed project. Indirect emissions included in this evaluation are those associated with increased electricity demand. The electrical demands due to propulsion of the electrical trains were calculated based on average engine size and the associated electrical demand. Average GHG emission factors for each kilowatt-hour were obtained from EPA's Emissions & Generation Resource Integrated Database (eGRID) electrical generation data based on emission profiles from the Oklahoma and Texas electrical grids. The eGRID sub-region SPP South (SPSO) was used for the Northern Section, while the sub-region ERCOT ALL (ERCT) regional factors were used for the Central and Southern sections. Criteria pollutant emission factors were developed based on the annual electricity output from eGRID and the annual state wide emissions from combustion of power sources from EPA's national emissions inventory database. Emissions associated with the potential increase in electrical demand were calculated for alternatives with electrical train options. While these emissions would not be located directly adjacent to the railway, they are accounted for in the regional emissions totals. Emissions for electric-powered locomotives are provided in Appendix A, Table A-4.

4.1.2.4 Diesel Locomotive Emissions

Railroad activity releases emissions, primarily from diesel combustion during train operations. Emissions of NO_x and primary $PM_{2.5}$ from diesel combustion contribute to ambient concentrations of ozone and $PM_{2.5}$, pollutants for which many states have areas out of attainment with the NAAQS. Diesel combustion also releases air toxics and GHGs, pollutants for which many states have established reduction programs.

Emissions from diesel engine locomotives were calculated using emission factors published by EPA, Emission Factors for Locomotives (EPA 2009) and the train schedules developed in the traffic technical evaluation. Emissions from diesel locomotives are provided in Appendix A, Table A-5.

4.1.3 Localized Effects

Localized vehicle emissions of CO would occur at locations when a large amount of vehicles are idling, such as at congested intersections. During construction there may be additional traffic delays due to the increased need for construction crews and delivery of material. These delays would generally be short in duration.

During operation, vehicles traveling to and from the stations or other rail facilities would have the potential to increase localized CO emissions at intersections or parking locations if such vehicle travel were to cause new congestion. In addition, localized PM and air toxic emissions would occur at locations with a substantial amount of diesel vehicle or diesel train travel/idling.

A localized adverse effect would occur if the alternative would cause a localized air emissions increase that has the potential to cause violation of the NAAQS, cause or contribute to a substantial air toxic emission increase that exposes sensitive populations to a high level of air toxic concentrations, or result in a stationary source that could not be permitted by the local regulatory agency due to a local increase in air emissions. For this service-level analysis, there is insufficient project-specific data available to make a determination regarding potential for substantial local effects. Therefore, where an alternative would have a higher potential for localized vehicle emissions of CO, PM, or air toxics, a detailed project-level localized effects analysis is recommended.

4.1.4 Greenhouse Gas Emissions

GHG emissions from the Program would be due to fossil fuel combustion of vehicles, diesel trains, airplanes, and power plants that provides electricity to meet the Program’s power demand. Potential change in GHG emissions from implementation of the Program were calculated for the same sources and categories as identified above in Section 4.1.2, Long-term Regional Effects.

4.2 Intensity of Effects Criteria

The air quality effects are characterized as negligible, moderate, or substantial as compared to the No Build Alternative.

A *substantial* effect on air quality would have some or all of the following characteristics:

- Short-Term Construction Effects: Construction emissions would be determined to have substantial adverse short-term effects if construction activities would generate air emissions in a quantity and location that would have the potential to cause or contribute to an exceedance of an ambient air quality standard or generate fugitive dust or other pollutants to a level that would be a nuisance. There are no beneficial short-term effects from construction for air quality.
- Long-Term Regional Operational Effects:
  - Regional Adverse Effects: Regional adverse effects would be substantial if the net increase in emissions of criteria pollutants is greater than 100 tons per year between the No Build Alternative and the build alternative.
  - Regional Beneficial Effects: Substantial beneficial effects on air quality are based on a noticeable reduction in air emissions due to the alternative. Although a substantial reduction may not directly result in a change of attainment status for a region, it would cause or contribute to an overall measureable and continued improvement to the air quality in the region. The improvement could be due to a reduction of criteria pollutants, air toxics, or GHG emissions. A regional beneficial effect on GHG emissions would occur if the alternative is consistent with federal, state, or local GHG reduction strategies.
- Localized Adverse Effects: A localized adverse effect would occur if the alternative would cause a localized air emissions increase that has the potential to cause violation of the NAAQS; cause or contribute to a substantial air toxic emission increase that exposes sensitive populations to a high level of air toxic concentrations; or result in a stationary source that could not be permitted by the local regulatory agency due to a local increase in air emissions. For this service-level analysis, there is insufficient project-specific data available to make a determination regarding potential for substantial local effects. Therefore, where an alternative would have a higher potential for localized vehicle emissions of CO, PM, or air toxics, a detailed project-level localized effects analysis is recommended.
- GHG Effects: An individual project does not generate enough GHG emissions to significantly influence global climate change. Rather, global climate change is a cumulative impact. This means that a project may contribute to a potential impact through its *incremental* change in emissions when combined with the contributions of all other sources of GHG. Currently there are no applicable quantitative GHG emission thresholds to determine the level of GHG and climate change impacts from an individual project. For this analysis, substantial regional adverse effects would occur when the alternative or the Program design are inconsistent with

federal, state, and local emission reduction goals. A regional beneficial effect would occur if the alternative is consistent with the federal, state, or local GHG-reduction goals.

A *moderate* effect would be noticeable, but overall the emissions and effects would be less than a substantial effect. Specifically, the effects would be moderate if the net increase in emissions from operations of criteria pollutants is less than 100 tons per year between the No Build Alternative and the build alternatives. A proportional reduction in short-term construction-related emissions and fugitive dust would result in a moderate effort.

A *negligible* effect is one that would result in similar or limited emissions compared to the No Build Alternative and would result in no noticeable change. Construction emissions would be determined to have negligible short-term effects if construction activities generate air emissions in a quantity and location that would not have the potential to cause or contribute to any exceedance of an ambient air quality standard and would also not generate fugitive dust or other pollutants to a level that would be a nuisance.

4.3 General Conformity

For project areas located in nonattainment and maintenance areas under NAAQS, the project would be subject to the general conformity rule and required to demonstrate compliance with the conformity requirements. The EPA Final Conformity Rule requires that total direct and indirect emissions of nonattainment and maintenance criteria pollutants, including ozone precursors (VOC and NO_x), be considered in determining conformity. If a federal action meets *de minimis* requirements established in 40 CFR 93.153(b), detailed conformity analyses are not required.

General conformity applicability analysis (e.g., to demonstrate that project emissions would be less than the general conformity *de minimis* levels) would be conducted at the project level for each project that is located in Dallas-Fort Worth nonattainment or maintenance areas. Further conformity determination will be required if the emissions exceed the *de minimis* levels for the nonattainment or maintenance pollutants.

5.0 Environmental Consequences

5.1 Overview

This sections discusses the air quality effects due to the implementation of the Program. Impacts were evaluated for the short-term construction emissions, long-term regional operational emissions, localized impacts of vehicle emissions of CO, PM, and air toxics, and GHG emissions.

In general, alternatives located in a nonattainment or maintenance area would have a greater potential for effects on air quality due to the already degraded state of air quality. Additionally, alternatives that have higher concentrations of air pollutants located near areas of higher population have the potential to expose more people to air pollutions. Each type of service (conventional rail, higher-speed rail, and high-speed rail) has general characteristics that would have similar effects regardless of alternative. Construction effects were evaluated not on the type of service, but based on the potential size and scale of construction. The operational effects by type of service are summarized and the long-term regional effects are similar for all alternatives evaluated unless otherwise noted.

5.1.1 Short-term Construction Effects

The Program would involve construction of the rails and other facilities such as stations and maintenance yards that support the operation of the rail system. These construction activities can result in short-term increases in dust and equipment-related emissions in and around the construction site. Exhaust emissions during construction would be generated by fuel combustion in motor vehicles and construction equipment, and particulate emissions would result from soil disturbance, earthwork, and other construction activities. Construction vehicle activity and disruption of normal traffic flow may result in increased motor vehicle emissions within certain areas.

Construction of the build alternatives would have the potential to cause temporary air quality impacts, and the extent of the impact would vary slightly based on alternative. In general, the degree of adverse construction effects is proportional to length of new rail proposed to be constructed, number of grade separations, number and size of new facilities, relationship of the alignment to populated areas, and the duration of construction at each site. The more non-road construction equipment used; the greater the potential for construction effects on air quality. Therefore, the alternatives with shorter route alignments, smaller right-of-way footprints, and/or using existing infrastructure and alignments would result in fewer effects on air quality from construction. Construction sites located farther away from populated areas would have less potential to cause air toxic effects on sensitive populations. Additionally, within the EIS Study Area, the Dallas and Fort Worth area is classified as a nonattainment area for ozone. Therefore, construction activities in the Dallas and Fort Worth area would have a greater potential effect on air quality than other regions due to the higher ambient background of ozone and ozone precursors.

Regardless of the differences in alternative service types (i.e., higher-speed, high-speed, or conventional), potential air quality impacts from each construction project would be short-term, occurring at a location only while construction work is in progress. Construction activities will comply with applicable federal, state, and local regulations and best management practices (BMPs) will be implemented to minimize emissions.

5.1.2 Long-Term Regional Operational Effects

Operation of the build alternatives would generally result in a long-term net benefit to air quality by reducing emissions of criteria pollutants, air toxics, and GHG. There are several factors which would contribute to the extent to which the operation of the alternative has a long-term effect on air quality. These include: the locomotive power source (diesel versus electric), operation of the stations and other supporting facilities, the forecasted ridership of the rail system and the subsequent vehicle and airplane emission change due to the shift of travel mode.

Alternatives that use electricity powered trains such as high-speed rail would result in much lower direct effects on air quality due to a decrease in overall fuel consumption compared to alternatives that use diesel locomotives such as the conventional rail and higher-speed rail. Electric-powered trains would have lower regional emissions, fewer local incidences of increased pollutant concentrations due to train idling, and fewer potential health effects from diesel PM.

While electric-powered trains would result in indirect emissions from power plants, these indirect emissions would be at a much lower levels compared to the diesel locomotive emissions. About 50 percent of electric power production for the Texas and Oklahoma is from coal, with the remainder of production from the combustion of natural gas and renewable sources, which generate fewer emissions than the combustion of diesel (U.S. Energy Information Administration 2014).

Alternatives with higher ridership would have the potential to shift more passengers from driving to riding the trains, thus decreasing the regional VMT and the associated vehicle emissions. In addition, longer route segments would provide access to more locations and would likely have a greater reduction in regional VMT. Since the high-speed rail service type is projected to have greater ridership than higher-speed rail for the same alignment, it would result in a greater reduction of air emissions in the region due to the combined effects of using electric-powered trains and higher ridership. Therefore, compared to the higher-speed rail service type, the high-speed rail service types for the same alignment have a larger reduction in regional air pollutant emissions and a greater net benefit to air quality than shorter routes.

Long-term regional effects of the build alternatives were evaluated based on the total direct and indirect emissions associated with the Program operation, Long-term operational emissions from trains, regional VMT changes, airplanes, and power generation are calculated for each Program alternative, except C4B Higher-Speed Rail and C4C Higher-Speed Rail. The traffic demand modeling for C4B Higher-Speed Rail and C4C Higher-Speed Rail was not performed at the same levels as other alternatives, therefore, emissions of these two alternatives were not quantified.

Total emissions of each alternative are summarized in Table 4-1. Detailed discussion of long-term regional effects of the No Build alternative and build alternatives are discussed in Section 5.2 through Section 5.5.

Table 5-1: Summary of Operational Regional Air Quality Emissions

Evaluation Years	VOC	CO	NO_x	SO_2	PM_{10}	$PM_{2.5}$	CO_2
N4A – Conventional: Emissions Tons per year							
2013	256	7,271	2,257	11	66	45	619,797
2035 No Build Alternative	20	2,857	256	4	59	15	569,972
2035 Build Alternative	20	2,841	255	4	59	15	566,919
C4A HSR: Emissions Tons per year							
2013	261	7,096	2,312	12	67	45	647,748
2035 No Build Alternative	44	4,126	1,051	8	90	29	990,694
2035 Build Alternative	23	3,104	133	5	70	15	880,246
C4A HrSR- Diesel Emissions Tons per year							
2013	234	7,294	1,578	12	47	25	620,683
2035 No Build Alternative	40	4,028	827	7	88	27	938,132
2035 Build Alternative	29	3,543	357	6	79	19	771,182
C4B HSR: Emissions Tons per year							
2013	226	7,014	1,529	12	46	24	597,632
2035 No Build Alternative	41	4,042	938	7	88	28	957,194
2035 Build Alternative	22	3,090	132	5	69	15	901,358
C4C HSR: Emissions Tons per year							
2013	225	6972	1,521	12	46	24	594,172
2035 No Build Alternative	44	4,112	1,050	8	89	29	987,791
2035 Build Alternative	23	3137	134	5	70	15	936,978
S4 HrSR - Diesel: Emissions Tons per year							
2013	485	16,236	2,521	24	75	31	1,226,662
2035 No Build Alternative	83	12,945	442	16	261	57	2,408,974
2035 Build Alternative	86	13,049	599	17	262	60	2,449,934
S6 HrSR – Diesel: Emissions Tons per year							
2013	97	3,232	516	5	16	7	246,172
2035 No Build Alternative	8	1,307	47	2	27	6	246,083
2035 Build Alternative	9	1,296	102	2	26	6	253,037
S6 HSR: Emissions Tons per year							
2013	97	3,232	516	5	16	7	246,172

Evaluation Years	VOC	CO	NO_x	SO_2	PM_{10}	$PM_{2.5}$	CO_2
2035 No Build Alternative	8	1,307	47	2	27	6	246,083
2035 Build Alternative	8	1,230	45	2	25	6	343,919

There was no projected change in air traffic or bus travel from 2013 to 2025 or as a reduction due to the build alternatives.

The Northern and Central sections have existing rail travel that was assumed to grow similar to that of the build alternatives and is diesel fueled based on the existing infrastructure. The southern section does not have any rail except for that associated with the project alternatives.

Traffic data provided by Steer Davies Gleave, March 1, 2016, version 2252703 – TOPRS Phase 3.

HrSR = higher-speed rail; HSR = high-speed rail

5.1.3 Localized Impacts

It is anticipated that the Program build alternatives would reduce overall traffic congestion of the region by removing passenger vehicles from roadways. Because localized CO and PM emissions tend to occur at locations with large amount of vehicles idling, such as at congested intersections, the program would be beneficial to reduce localized vehicle emissions by relieving traffic congestions.

While the conventional and potentially higher-speed service types could add new at-grade rail crossings that would increase localized vehicle emissions at those isolated locations, other service types such as high-speed rail would have grade separated crossing, therefore, would not increase localized vehicle emissions at these crossings. Traffic congestions and localized impacts of CO and PM may also occur near large rail stations on routes that passengers use to travel to and from the stations.

Localized air toxic emissions from the Program operation would have the potential to exposure nearby population to air toxics such as diesel PM. Potential localized air toxic emissions associated the Program operation would be mostly from the diesel locomotives idling. However, localized air toxic emissions from diesel train travel are expected to be limited due to the limited number of diesel locomotive would idle at a particular location. Localized air toxic effects would be higher in urban or populated areas due to the exposure of sensitive receptors. Alternatives with alignments and facilities located mostly in rural areas, such as those in Southern Sections, would likely have lower potential to cause localized air toxic exposure then alternatives located in Central Sections that has dense populated areas.

Electric trains idling would not emit air pollutants to increase local concentrations of pollutants near the alignment, nor would they increase the exposure of sensitive populations to toxic pollutants. Therefore, the high-speed rail alternatives would result in fewer local effects on air quality and air toxic exposure than the alternatives which would utilize diesel trains.

Increased travel speeds associated with the high-speed rail would have the potential to generate more fugitive dust compared to the operation of higher-speed rail. This would be minimized through the design and materials of the track as well as the grade separation requirement.

As discussed above, the Program would be beneficial in reducing localized effects in some cases and would have adverse effects in other cases. Final conclusions of localized effects would be greatly depend on design details information on affected locations and the corresponding traffic data that are not available as part of this service-level evaluation. Therefore, localized effects of the Program would be evaluated at the project level when project specific information becomes available and are not further concluded in this study.

5.1.4 General Conformity

For alignments that are located in the Dallas and Fort Worth area that is designated as nonattainment for ozone, the Program would be subject to conformity requirements. A general conformity determination would be required during project level analysis if project construction and operation emissions would exceed the general conformity *de minimis* levels. Because project level information is not currently available, analysis related to general conformity will be performed during project-level analysis, and a conclusion is not made in this service level analysis.

5.2 No Build Alternative

The No Build Alternative, as described in Chapter 2 (Section 2.2) and the introduction to Chapter 3, of the Draft EIS, is used as the baseline to evaluate the air quality effects of the build alternatives. The No Build Alternative would not implement the Program of rail improvements associated with this service-level evaluation and would not meet the purpose and need of the Program. The No Build Alternative would not require any construction. Therefore, there are no short term effects on air quality from the No Build Alternative.

Existing air quality, compared to air quality in 2035 without the project, would be affected by two key factors: regional growth and air quality regulatory actions. Regional growth, such as increased residential development and density, along with additional industry, results in more and greater sources of air emissions. These increases in air emissions are offset by transportation projects which generally reduce traffic congestion, thus minimizing local effects for emissions, as well as vehicle regulatory programs that control the level of emissions from on-road and non-road vehicles.

Due to the Texas Motor Vehicle Fuel Programs, the TERP, and the Vehicle I/M Program, it is expected that pollutant burdens for VOC, CO, NOx, and PM would continue to decrease from the current conditions to 2035 (TCEQ 2014c). The Fuel Programs such as the Texas Low Emission Diesel Fuel Program initially implemented in 2005 will continue to reduce emissions in the region (TCEQ 2014d). Emissions will continue to be reduced from of the TERP and the I/M Programs due to the phasing of implementation dates (TCEQ 2014c). Additionally, under the No Build Alternative, several roadway and mass transit projects, as discussed in the Alternative section, are designed to alleviate congestion through the entire region. The effect of the federal mobile vehicle emission reduction programs is included in Motor Vehicle Emission Simulator emission factors and reflected in the 2035 alternative emission evaluations. Regional emission reduction programs would reduce the future emission of the project area. The No Build Alternative would not require construction and operation of any component of the Program.

5.3 Northern Section: Oklahoma City to Dallas and Fort Worth

5.3.1 Alternative N4A Conventional Rail

5.3.1.1 Construction

Alternative N4A would primarily use the existing rail infrastructure, which would require minimal construction activities to implement this alternative. Due to the limited construction emissions associated with these minimal construction activities, short-term effects on air quality would be negligible for Alternative N4A.

5.3.1.2 Operation

Relative to the No Build Alternative, Alternative N4A would slightly decrease the amount of travel by personal vehicles, which are typically gasoline fueled. Therefore, Alternative N4A would result in slightly lower regional emissions from personal vehicles compared to the No Build Alternative. Alternative N4A would use Tier 4 or similar diesel locomotive engines. As shown in Table 4-1, there would be a negligible reduction (less than 1 percent) in CO, NO_x, and CO_2 pollutants relative to the No Build Alternative. Because regional criteria pollutants and GHG emissions from Alternative N4A would be similar or slightly lower relative to the No Build Alternative, the overall benefit in regional air quality would be negligible

5.4 Central Section: Dallas and Fort Worth to San Antonio

The construction of any of the Central Section alternatives would be a major infrastructure project and would occur in an area that is currently designated as serious nonattainment for ozone. Even with mitigation, all Central Section alternatives under consideration would likely result in substantial short term effects on air quality during construction.

5.4.1 Alternative C4A Higher-Speed Rail

5.4.1.1 Construction

Construction of Alternative C4A Higher-Speed Rail would be a major infrastructure project and would occur in an area that is currently designated as nonattainment for ozone. It is anticipated that the construction of C4A Higher-Speed Rail would generate substantial short-term regional air quality emissions.

5.4.1.2 Operation

Operation of the alternative would reduce criteria pollutants and GHG emissions compared to No Build Alternative, as shown in Table 4-1. Emissions of criteria pollutants with this alternative would be reduced by 10 to 57 percent compared to No Build Alternative, with NO_x having the greatest reduction, attributed mostly to the reduced travel time of the higher-speed rail service types and their resulting reduced fuel usage.

GHG emissions are generated from the combustion of fossil fuels. As shown in Table 4-1, the regional reduction in emissions would be approximately 167,000 tons per year, or 18 percent for CO_2 compared to the No Build Alternative. Emission reductions of GHG are mainly due to the reduced travel time and resulting reduced fuel usage.

Because the air pollution emissions would be greatly reduced, Alternative C4A Higher-Speed Rail would have substantial regional benefits.

5.4.2 Alternative C4A High-Speed Rail

5.4.2.1 Construction

Alternative C4A High-Speed Rail would result in higher short-term construction emissions compared the higher-speed rail service type because it would require more grade-separated segments, a larger construction footprint, and more mobilization effort due to the high-speed rail track and station design requirements. The scale of the construction project would likely result in a substantial effect on regional air quality.

5.4.2.2 Operation

Operation of Alternative C4A High-Speed Rail would have greater regional beneficial impacts on air quality due to the higher ridership (reducing reliance on vehicles) and use of electric trains. As shown in Table 4-1, emissions of criteria pollutants would be reduced by 25 to 87 percent compared to No Build Alternative, with NO_x having the highest reduction, attributed mostly to the use electric-powered trains.

The regional reduction in emissions would be approximately 110,000 tons per year, or 11 percent, for CO_2 compared to the No Build Alternative, mostly due to the use of electric-powered trains and the passenger vehicle emission reduction when people switch from driving to riding the trains.

Because the air pollution emissions would be greatly reduced, Alternative C4A High-Speed Rail would have substantial long-term regional benefits.

5.4.3 Alternative C4B Higher-Speed Rail

5.4.3.1 Construction

Similar to Alternative C4A Higher-Speed Rail, construction of Alternative C4B Higher-Speed Rail would also represent a major infrastructure project in an area that is currently designated as nonattainment for ozone. However, as the shortest rail alignment with the smallest right-of-way, Alternative C4B Higher-Speed Rail is expected to result in fewer short-term impacts effects on air quality from construction than Alternative C4A Higher-Speed Rail would. There is a potential for substantial short-term effects on air quality.

5.4.3.2 Operation

For this service-level analysis, the travel demand modeling for Alternative C4B Higher-Speed Rail was not conducted to the same level of detail as Alternative C4A Higher-Speed Rail, but instead relied upon a proportional relationship based on full travel demand modeling conducted for Alternatives C4A High-Speed Rail and C4A Higher-Speed Rail. This appropriate level of detail applied for Alternative C4B Higher-Speed Rail is supported by a linear proportional adjustment in ridership and demand, which is based on the relationship between Alternatives C4A High-Speed Rail and C4A Higher-Speed Rail, thereby producing reasonably accurate estimates for Alternative C4B Higher-Speed Rail.

The higher-speed rail service type would use diesel train during operation. However, the overall emissions of each criteria pollutant and GHG are expected to decrease compared to the No Build, similar to C4A Higher-Speed Rail, but at a reduced level due to the shorter alignment and subsequently less vehicles being removed from road. The air pollution emissions would be reduced, similar to Alternative C4A Higher-Speed Rail; the corresponding reductions, taking into account the shorter alignment, would have moderate regional benefits.

5.4.4 Alternative C4B High-Speed Rail

5.4.4.1 Construction

Alternative C4B High-Speed Rail would have design of rail tracks, facilities, and grade-separated crossings similar to Alternative C4A High-Speed Rail but would have a shorter rail alignment and smaller right-of-way. Air quality effects from construction of Alternative C4B High-Speed Rail would likely be fewer than those associated with Alternative C4A High-Speed Rail. Alternative C4B High-Speed Rail would likely have short-term moderate effects on air quality.

5.4.4.2 Operation

Alternative C4B High-Speed Rail would have a shorter alignment than Alternative C4A High-Speed Rail and as a result VMT reductions would be smaller. Operation of Alternative C4B High-Speed Rail would result in similar but slightly fewer benefits than Alternative C4A High-Speed Rail, as compared to the No Build Alternative. As shown in Table 4-1, emissions of criteria pollutants would be reduced by 22 to 86 percent compared to No Build Alternative, with NO_x having the highest reduction, attributed mostly to the use electric-powered trains. The regional reduction in CO_2 emissions would be approximately 56,000 tons per year, or 18 percent, compared to the No Build Alternative.

Because the air pollution emissions would be greatly reduced, Alternative C4A High-Speed Rail would have substantial long-term regional benefits

5.4.5 Alternative C4C Higher-Speed Rail

5.4.5.1 Construction

Air quality effects from construction of Alternative C4C Higher-Speed Rail would be similar to but greater than those identified for Alternative C4A Higher-Speed Rail due to the longer alignment for the C4C alternative. Alternative C4C Higher-Speed Rail would likely have substantial short-term effects on air quality.

5.4.5.2 Operation

For this service-level analysis, the travel demand modeling for Alternative C4C Higher-Speed Rail was not conducted to the same level of detail as for C4A Higher-Speed Rail, but instead relied upon a proportional relationship based on full travel demand modeling conducted for the C4A High-Speed Rail and C4A Higher-Speed Rail alternatives. This appropriate level of detail applied for Alternative C4C Higher-Speed Rail is supported by a linear proportional adjustment in ridership and demand, which is based on the relationship between the C4A High-Speed Rail and C4A Higher-Speed Rail alternatives, thereby producing reasonably accurate estimates for Alternative C4C Higher-Speed Rail.

Air quality effects from the operation of Alternative C4C Higher-Speed Rail would be similar to those discussed for Alternative C4A Higher-Speed Rail. Similar to C4A Higher-Speed Rail, but with a slightly increased level due to the longer alignment and more vehicles removed from the road, the air pollution emissions would be reduced and the corresponding reductions, taking into account the longer alignment, would have substantial regional benefits.

5.4.6 Alternative C4C High-Speed Rail

5.4.6.1 Construction

Construction emissions of Alternative C4C High-Speed Rail would be higher than Alternative C4C Higher-Speed Rail due to the construction of grade-separated crossing. Alternative C4C High-Speed Rail would likely to have substantial short-term effects on air quality.

5.4.6.2 Operation

Operation of Alternative C4C High-Speed Rail would result in similar but slightly fewer benefits than Alternative C4A High-Speed Rail, as compared to the No Build Alternative. As shown in Table 4-1, emissions of criteria pollutants would be reduced by 21 to 87 percent compared to No Build Alternative, with NO_x having the highest reduction, attributed mostly to the use electric-powered trains. The regional reduction in CO2 emissions would be approximately 51,000 tons per year, or 5 percent compared to the No Build Alternative.

Because the air pollution emissions would be greatly reduced, Alternative C4C High-Speed Rail would have substantial long-term regional benefits.

5.5 Southern Section: San Antonio to South Texas

5.5.1 Alternative S4 Higher-Speed Rail

5.5.1.1 Construction

Construction of Alternative S4 Higher-Speed Rail would be a major infrastructure project. While the area is in attainment for ozone there is active management of ozone precursors in accordance with the Ozone Flex Plan (TCEQ 2007). Alternative S4 Higher-Speed Rail would be located in a mostly rural area and the station capacity is expected to be less than half that of the stations associated with the Central Section Alternatives. However, there is minimal existing rail infrastructure in the Southern Section, as shown in Section 3.20, Transportation, in the Draft EIS, which indicates there would be no existing or future passenger rail service in the area without the Program. Therefore, the major infrastructure construction required for this alternative would result in a substantial short-term effect on air quality.

5.5.1.2 Operation

The regional emissions for Alternative S4 Higher-Speed Rail compared to the No Build Alternative are included in Table 4-1. Alternative S4 Higher-Speed Rail is expected to have an increase in criteria pollutants and GHG emissions compared to the No Build Alternative. This is because, although there would be a reduction in personnel VMT, the traffic modeling evaluation projected no change in bus or air miles traveled, and there is no future rail travel included in the No Build Alternative. Therefore, while Alternative S4 Higher-Speed Rail would provide additional modes of transport in the region the use of diesel-powered trains would increase emissions from Alternative S4 Higher-Speed Rail compared to the No Build Alternative for all pollutants evaluated. For NO_x and CO, the increase is estimated to be approximately 157 and 104 tons per year, respectively. The CO_2 emissions increase would be approximately 41,000 tons per year, or 2 percent, compared to the No Build Alternative. The increase in other pollutants would be negligible.

Because the emission increases associated with Alternative S4 Higher-Speed Rail would be greater than 100 tons per year for CO and NO_x, it would have substantial regional adverse effects during operation.

5.5.2 Alternative S6 Higher-Speed Rail

5.5.2.1 Construction

The alignment length of Alternative S6 Higher-Speed Rail is approximately one third the length of the S4 Higher-Speed Rail and S6 High-Speed Rail alternative alignments. Therefore, Alternative S6 Higher-Speed Rail would have lower construction emissions than S4 Higher-Speed Rail and S6 High-Speed Rail. Construction of Alternative S6 Higher-Speed Rail would likely result in moderate effects on air quality.

5.5.2.2 Operation

While Alternative S4 Higher-Speed Rail has a much longer alignment than S6 Higher-Speed Rail and is projected to have a lower level of ridership than Alternative S6 Higher-Speed Rail, there would be a proportionally greater reduction in regional VMT with Alternative S6 Higher-Speed Rail compared to S4 Higher-Speed Rail. As shown in Table 4-1, Alternative S6 Higher-Speed Rail would have a negligible reduction in emissions of PM and CO compared to the No Build Alternative. NO_x would increase by approximately 55 tons per year, and GHG would increase by 7,000 tons per year. Increases of NO_x and GHG emissions are mostly due to the use of diesel-powered trains for Alternative S6 Higher-Speed Rail and the extremely low baseline emissions of the No Build Alternative. Because the alternative would cause criteria pollution emissions less than 100 tons per year, it would have moderate adverse effect on air quality during operation.

5.5.3 Alternative S6 High-Speed Rail

5.5.3.1 Construction

Construction of Alternative S6 High-Speed Rail would have potential for higher short-term air quality effects than Alternative S6 Higher-Speed Rail due to the increased construction footprint and elevated structures required. Construction of Alternative S6 High-Speed Rail would likely result in short-term substantial effects on air quality.

5.5.3.2 Operation

Operation of the Alternative S6 High-Speed Rail would have greater beneficial effects than Alternative S6 Higher-Speed Rail due to the use of electric-powered trains. Although the high-speed rail service type would result in increases in emissions from power production, the associated indirect increase in emissions from power generation would be lower than emissions associated with diesel locomotives in Alternative S6 Higher-Speed Rail. These criteria and GHG emissions would not be local and would be distributed throughout the state's existing power supply sources, which are required to operate within their permit limits. The permits are issued on the basis that operation of the power plants will not result in an exceedance of an ambient air quality standard.

The reduction in regional emissions associated with Alternative S6 High-Speed Rail would be negligible to moderate, or less than 7 percent, compared to No Build Alternative, for the pollutants evaluated except for CO_2. There would be an increase in CO_2 emissions due to the indirection emissions from power generation. Although there is projected to be an increase in GHG emissions for this alternative, it is primarily due to the addition of a transportation mode that did not previously exist in the region. Alternative S6 High-Speed Rail would be consistent with long-term federal and state goals to reduce the reliance on fossil fuels for new transportation alternatives because it would use electricity rather than direct combustion of diesel.

Due to the minimal emission reduction of criteria pollutant, Alternative S6 High-Speed Rail would have negligible long-term regional benefits.

6.0 Potential Mitigation Strategies

6.1 Construction Phase

Temporary, short-term emissions increases associated with construction activities, and potential localized air pollution increases associated with traffic near proposed stations would be substantially reduced by the application of mitigation strategies and design practices. Potential emission reduction measures include, but are not limited to:

- Use of low-emissions vehicles during construction, and use of newer and well-maintained equipment.
- Effects from concrete and asphalt batch plants would be limited by placing these facilities farther from sensitive populations, such as schools, hospitals, and residences, to the extent possible.
- Potential fugitive dust effects would be mitigated through best management practices such as water sprays during demolition; wetting, paving, or landscaping exposed earth areas; covering dust-producing materials during transport; limiting dust-producing construction activities during high wind conditions; and providing street sweeping and tire washes for trucks leaving the site.
- Traffic congestion emissions can be reduced using site-specific traffic management plans; temporary signage and other traffic controls; designated staging areas, worker parking lots (with shuttle bus service if necessary), and truck routes; and prohibition of construction vehicle travel during peak traffic periods.

Localized air pollutant increases associated with traffic near construction sites would be addressed by mitigation strategies discussed in Section 3.20, Transportation, in the Draft EIS, as well as implementing enhanced accessibility and signal design practices.

6.2 Operational Phase

Avoidance and minimization of effects at the project-level would be incorporated when feasible. If effects cannot be avoided or minimized, mitigation strategies would be implemented. Strategies for managing emissions from diesel trains could addressed by using Tier 4 locomotive engines, and implementing additional measures to reduce diesel locomotive idling times. Locating the tracks, stations, and other supporting facilities away from populated areas and sensitive receptors would minimize and reduce the potential exposure to air toxics from diesel combustion.

7.0 Subsequent Analysis

7.1 Construction and Operation Emissions

A detailed quantification of construction emissions based on the proposed segment and station construction will be conducted during project-level analysis. Project operation analysis will include emissions from operating the trains and stations of the alternatives and will include regional changes in emissions due to mode change. Based on the refined segment options, a detailed evaluation of the potential changes in VMT for all modes affected, including personal vehicles, airplanes, buses, and conventional train, will be included in subsequent analysis. The evaluation will also include the quantification of both direct and indirect air emissions during operation.

7.2 Localized Impacts

Localized impacts of CO, PM, and air toxics during operation will be performed during project-level analysis when project-specific information is available and will only be for alternative operations that are determined to have potential to increase localized emissions substantially. If a quantitative modeling analysis is triggered, air dispersion modeling of CO or PM will be conducted for locations that would have the potential to cause an exceedance of NAAQS, even with mitigation.

7.3 General Conformity

For alternatives located in the Dallas and Fort Worth area that is designated as nonattainment or maintenance for ozone, construction and operation emission evaluations will be performed and compared to the general conformity *de minimis* levels to demonstrate compliance with general conformity requirements. A general conformity evaluation is not required for projects located in attainment areas.

7.4 Greenhouse Gases and Climate Change

GHG emissions and the associated climate change impacts due to project emissions will be analyzed for the alternatives. GHG emissions from project operation in the study area will be quantified. In addition, a qualitative discussion of project adaptation to the effects of climate change will be included in the project-level analysis.

8.0 References

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Appendix A

Emission Calculations

Summary Tables

Existing 2013

		Existing 2013 Emissions Tons per year [1]						
		VOC	CO	NOx	SO2	PM10	PM2.5	CO2
N4Ac	Auto	206.38	7,078.95	1,201.45	10.76	37.77	17.45	545,734.47
	Bus	0.48	2.20	9.46	0.01	0.47	0.39	1,343.80
	Airplane	0.02	0.18	0.06	0.01	0.00	0.00	19.03
	Rail - Electric	0.05	0.26	0.52	0.32	0.04	0.03	1,126,794.14
	Rail - Diesel	49.10	189.44	1,045.95	0.67	27.75	26.92	72,699.31
	Total	255.97	7,270.76	2,256.92	11.45	65.99	44.76	619,796.61
C4Ahsr	Auto	209.04	6,890.87	1,208.80	11.18	36.12	15.43	566,737
	Bus	2.87	13.09	55.90	0.07	2.78	2.35	8,030
	Airplane	0.24	2.61	0.85	0.12	0.02	0.02	281
	Rail - Electric	0.01	0.16	0.15	0.24	0.02	0.01	1,211,577
	Rail - Diesel	49.10	189.44	1,045.95	0.67	27.75	26.92	72,699.31
C4Ah	Auto	219.41	7,232.50	1,268.73	11.73	37.91	16.19	594,834.55
	Bus	2.87	13.09	55.90	0.07	2.78	2.35	8,030.42
	Airplane	0.24	2.61	0.85	0.12	0.02	0.02	280.65
	Rail - Electric	0.01	0.16	0.15	0.24	0.02	0.01	1,211,576.68
	Rail - Diesel	11.84	45.70	252.31	0.16	6.69	6.49	17,537.12
C4Bhsr	Auto	210.91	6,952.24	1,219.57	11.28	36.44	15.57	571,784.19
	Bus	2.87	13.09	55.90	0.07	2.78	2.35	8,030.42
	Airplane	0.24	2.61	0.85	0.12	0.02	0.02	280.65
	Rail - Electric	0.01	0.16	0.15	0.24	0.02	0.01	1,211,576.68
	Rail - Diesel	11.84	45.70	252.31	0.16	6.69	6.49	17,537.12
C4Chsr	Auto	209.63	6,910.16	1,212.19	11.21	36.22	15.47	568,323.79
	Bus	2.87	13.09	55.90	0.07	2.78	2.35	8,030.42
	Airplane	0.24	2.61	0.85	0.12	0.02	0.02	280.65
	Rail - Electric	0.01	0.16	0.15	0.24	0.02	0.01	1,211,576.68
	Rail - Diesel	11.84	45.70	252.31	0.16	6.69	6.49	17,537.12
	Totals By Alternative							
	C4Ahsr [1]	261.25	7,096.01	2,311.51	12.04	66.67	44.71	647,747.75
	C4Ah - Electric [1]	~~222.54~~	~~7,248.36~~	~~1,325.64~~	~~12.16~~	~~40.73~~	~~18.57~~	~~1,814,722.30~~
	CAAh-Diesel [1]	234.37	7,293.90	1,577.80	12.09	47.41	25.05	620,682.73
	C4Bhsr [1]	225.86	7,013.63	1,528.64	11.63	45.94	24.43	597,632.38
	C4Chsr [1]	224.59	6,971.56	1,521.26	11.56	45.72	24.33	594,171.97
S4h	Auto	481.53	16,222.32	2,465.25	24.02	71.79	28.03	1,218,125.96
	Bus	3.05	13.90	56.07	0.07	2.95	2.49	8,535.96
	Airplane	-	-	-	-	-	-	-
	Rail - Electric	-	-	-	-	-	-	-
	Rail - Diesel	-	-	-	-	-	-	-
S6h	Auto	95.75	3,225.82	490.22	4.78	14.27	5.57	242,225.17
	Bus	1.41	6.43	25.92	0.03	1.36	1.15	3,946.65
	Airplane	-	-	-	-	-	-	-
	Rail - Electric	-	-	-	-	-	-	-
	Rail - Diesel	-	-	-	-	-	-	-
S6hsr	Auto	95.75	3,225.82	490.22	4.78	14.27	5.57	242,225.17
	Bus	1.41	6.43	25.92	0.03	1.36	1.15	3,946.65
	Airplane	-	-	-	-	-	-	-
	Rail - Electric	-	-	-	-	-	-	-
	Rail - Diesel	-	-	-	-	-	-	-
	Totals By Alternative							
	S4h - Electric [1]	484.58	16,236.22	2,521.32	24.09	74.74	30.52	1,226,661.92
	S4h - Diesel	484.58	16,236.22	2,521.32	24.09	74.74	30.52	1,226,661.92
	S6h - Electric [1]	97.16	3,232.25	516.14	4.81	15.64	6.73	246,171.82
	S6h - Diesel	97.16	3,232.25	516.14	4.81	15.64	6.73	246,171.82
	S6hsr [1]	97.16	3,232.25	516.14	4.81	15.64	6.73	246,171.82

[1] Assume No bulid and existing rail are all diesel fueled trains.

[2] Southern options are in some cases projected to be higher emissions for some pollutants for the build options due to no rail or airplane travel in the existing scenario or that which will be used in the future No Build Scenario.

No Build 2035

		No Build 2035 Emissions Tons per year[1]						
		VOC	**CO**	**NOx**	**SO2**	**PM10**	**PM2.5**	**CO2**
N4Ac	Auto	17.16	2,736.19	105.47	3.54	56.76	12.40	522,403
	Bus	0.04	0.32	1.12	0.01	0.11	0.04	1,286
	Airplane	0.02	0.14	0.05	0.01	0.00	0.00	19
	Rail - Electric	0.05	0.26	0.52	0.32	0.04	0.03	1,126,794
	Rail - Diesel	3.17	120.55	149.42	0.43	2.26	2.20	46,263
	Total	20.39	2,857.20	256.06	3.98	59.13	14.63	569,971.59

C4Ahsr	Auto	24.07	3,390.53	136.90	4.75	75.25	15.93	702,131
	Bus	0.26	1.91	6.61	0.06	0.65	0.22	7,689
	Airplane	0.22	2.04	0.79	0.12	0.02	0.02	280
	Rail - Electric	0.20	2.52	2.42	3.85	0.28	0.22	1,211,577
	Rail - Diesel	19.22	731.17	906.27	2.58	13.73	13.32	280,594
C4Ah	Auto	24.67	3,475.46	140.32	4.87	77.13	16.33	719,718
	Bus	0.26	1.91	6.61	0.06	0.65	0.22	7,689
	Airplane	0.22	2.04	0.79	0.12	0.02	0.02	280
	Rail - Electric	0.15	1.89	1.82	2.88	0.21	0.16	1,211,577
	Rail - Diesel	14.42	548.37	679.70	1.93	10.30	9.99	210,445
C4Bhsr	Auto	24.12	3,398.14	137.20	4.76	75.42	15.96	703,705
	Bus	0.26	1.91	6.61	0.06	0.65	0.22	7,689
	Airplane	0.22	2.04	0.79	0.12	0.02	0.02	280
	Rail - Electric	0.18	2.21	2.12	3.37	0.25	0.19	1,211,577
	Rail - Diesel	16.82	639.77	792.98	2.26	12.01	11.65	245,520
C4Chsr	Auto	23.97	3,376.52	136.33	4.73	74.94	15.86	699,228
	Bus	0.26	1.91	6.61	0.06	0.65	0.22	7,689
	Airplane	0.22	2.04	0.79	0.12	0.02	0.02	280
	Rail - Electric	0.20	2.52	2.42	3.85	0.28	0.22	1,211,577
	Rail - Diesel	19.22	731.17	906.27	2.58	13.73	13.32	280,594
	Totals By Alternative							
	C4Ahsr[1]	43.77	4,125.65	1,050.57	7.52	89.65	29.49	990,693.53
	C4Ah - Electric[1]	~~25.30~~	~~3,481.31~~	~~149.55~~	~~7.95~~	~~78.02~~	~~16.73~~	~~1,939,263.75~~
	CAAh-Diesel[1]	39.57	4,027.79	827.43	7.00	88.10	26.56	938,132.45
	C4Bhsr[1]	41.43	4,041.86	937.59	7.21	88.10	27.86	957,193.86
	C4Chsr[1]	43.67	4,111.64	1,050.00	7.50	89.34	29.42	987,790.73

S4h	Auto	82.28	12,943.27	435.12	16.22	260.21	57.26	2,400,800
	Bus	0.27	2.03	6.63	0.07	0.69	0.24	8,174
	Airplane	-	-	-	-	-	-	-
	Rail - Electric	-	-	-	-	-	-	-
	Rail - Diesel	-	-	-	-	-	-	-
S6h	Auto	8.30	1,306.32	43.91	1.64	26.26	5.78	242,304
	Bus	0.13	0.94	3.07	0.03	0.32	0.11	3,779
	Airplane	-	-	-	-	-	-	-
	Rail - Electric	-	-	-	-	-	-	-
	Rail - Diesel	-	-	-	-	-	-	-
S6hsr	Auto	8.30	1,306.32	43.91	1.64	26.26	5.78	242,304
	Bus	0.13	0.94	3.07	0.03	0.32	0.11	3,779
	Airplane	-	-	-	-	-	-	-
	Rail - Electric	-	-	-	-	-	-	-
	Rail - Diesel	-	-	-	-	-	-	-
	Totals By Alternative							
	S4h - Electric[1]	82.55	12,945.30	441.75	16.29	260.90	57.50	2,408,974.13
	S4h - Diesel	82.55	12,945.30	441.75	16.29	260.90	57.50	2,408,974.13
	S6h - Electric[1]	8.43	1,307.25	46.98	1.67	26.58	5.89	246,083.02
	S6h - Diesel	8.43	1,307.25	46.98	1.67	26.58	5.89	246,083.02
	S6hsr[1]	8.43	1,307.25	46.98	1.67	26.58	5.89	246,083.02

[1] Assume No bulid and existing rail are all diesel fueled trains.

[2] Southern options are in some cases projected to be higher emissions for some pollutants for the build options due to no rail or airplane travel in the existing scenario or that which will be used in the future No Build Scenario.

Build 2035

		Build 2035 Emissions Tons per year						
		VOC	CO	NOx	SO2	PM10	PM2.5	CO2
N4Ac	Auto	17.06	2,720.20	104.85	3.52	56.42	12.32	519,351
	Bus	0.04	0.32	1.12	0.01	0.11	0.04	1,286
	Airplane	0.02	0.14	0.05	0.01	0.00	0.00	19
	Rail - Electric	0.03	0.17	0.33	0.20	0.02	0.02	717,051
	Rail - Diesel	3.17	120.55	149.42	0.43	2.26	2.20	46,263
	Total	20.29	2,841.21	255.45	3.96	58.80	14.56	566,919.29

C4Ahsr	Auto	22.01	3,100.06	125.17	4.35	68.80	14.56	641,978
	Bus	0.26	1.91	6.61	0.06	0.65	0.22	7,689
	Airplane	0.22	2.04	0.79	0.12	0.02	0.02	280
	Rail - Electric	0.04	0.48	0.46	0.73	0.05	0.04	230,300
	Rail - Diesel	3.65	138.98	172.27	0.49	2.61	2.53	53,336
C4Ah	Auto	23.90	3,366.35	135.92	4.72	74.71	15.81	697,123
	Bus	0.26	1.91	6.61	0.06	0.65	0.22	7,689
	Airplane	0.22	2.04	0.79	0.12	0.02	0.02	280
	Rail - Electric	0.05	0.59	0.57	0.91	0.07	0.05	380,495
	Rail - Diesel	4.53	172.22	213.46	0.61	3.23	3.14	66,090
C4Bhsr	Auto	21.91	3,085.96	124.60	4.33	68.49	14.50	639,058
	Bus	0.26	1.91	6.61	0.06	0.65	0.22	7,689
	Airplane	0.22	2.04	0.79	0.12	0.02	0.02	280
	Rail - Electric	0.04	0.46	0.45	0.71	0.05	0.04	254,331
	Rail - Diesel	3.53	134.30	166.46	0.47	2.52	2.45	51,539
C4Chsr	Auto	22.24	3,132.25	126.47	4.39	69.52	14.71	648,645
	Bus	0.26	1.91	6.61	0.06	0.65	0.22	7,689
	Airplane	0.22	2.04	0.79	0.12	0.02	0.02	280
	Rail - Electric	0.05	0.58	0.56	0.89	0.07	0.05	280,365
	Rail - Diesel	4.45	169.20	209.71	0.60	3.18	3.08	64,931
	Totals By Alternative							
	C4Ahsr	22.53	3,104.49	133.03	5.27	69.53	14.85	880,246.47
	C4Ah - Electric	24.43	3,370.90	143.89	5.81	75.45	16.11	1,085,587.36
	CAAh-Diesel	28.91	3,542.52	356.78	5.52	78.62	19.19	771,182.49
	C4Bhsr	22.42	3,090.38	132.45	5.22	69.21	14.78	901,357.61
	C4Chsr	22.76	3,136.79	134.43	5.47	70.25	15.01	936,978.50

S4h	Auto	82.12	12,917.74	434.26	16.19	259.69	57.15	2,396,066
	Bus	0.13	0.94	3.07	0.03	0.32	0.11	3,779
	Airplane	-	-	-	-	-	-	-
	Rail - Electric	0.04	0.45	0.43	0.69	0.05	0.04	576,751
	Rail - Diesel	3.43	130.52	161.78	0.46	2.45	2.38	50,089
S6h	Auto	7.94	1,249.10	41.99	1.57	25.11	5.53	231,691
	Bus	0.13	0.94	3.07	0.03	0.32	0.11	3,779
	Airplane	-	-	-	-	-	-	-
	Rail - Electric	0.01	0.16	0.15	0.24	0.02	0.01	202,263
	Rail - Diesel	1.20	45.77	56.74	0.16	0.86	0.83	17,566
S6hsr	Auto	7.81	1,229.16	41.32	1.54	24.71	5.44	227,993
	Bus	0.13	0.94	3.07	0.03	0.32	0.11	3,779
	Airplane	-	-	-	-	-	-	-
	Rail - Electric	0.01	0.18	0.17	0.27	0.02	0.02	112,146
	Rail - Diesel	1.33	50.76	62.91	0.18	0.95	0.92	19,479
	Totals By Alternative							
	S4h - Electric	82.28	12,919.13	437.76	16.91	260.06	57.30	2,976,595.54
	S4h - Diesel	85.67	13,049.20	599.11	16.68	262.46	59.64	2,449,934.47
	S6h - Electric	8.08	1,250.20	45.21	1.84	25.45	5.65	437,733.88
	S6h - Diesel	9.27	1,295.81	101.79	1.76	26.29	6.47	253,036.77
	S6hsr	7.95	1,230.28	44.56	1.84	25.05	5.56	343,918.58

Evaluation Years	N4A - Conventional: Emissions Tons per year						
	VOC	CO	NOx	SO2	PM10	PM2.5	CO2
2013	256	7,271	2,257	11	66	45	619,797
2035 No Build	20	2,857	256	4	59	15	569,972
2035 Project Alterative	20	2,841	255	4	59	15	566,919

Evaluation Years	VOC	CO	NOx	SO2	PM10	PM2.5	CO2
	C4AHDR - HSR : Emissions Tons per year						
2013	261	7,096	2,312	12	67	45	647,748
2035 No Build	44	4,126	1,051	8	90	29	990,694
2035 Project Alterative	23	3,104	133	5	70	15	880,246
	C4AH - HRSR- Electric : Emissions Tons per year						
2013	223	7,248	1,326	12	41	19	1,814,722
2035 No Build	25	3,481	150	8	78	17	1,939,264
2035 Project Alterative	24	3,371	144	6	75	16	1,085,587
	C4AH - HRSR- Diesel : Emissions Tons per year						
2013	234	7,294	1,578	12	47	25	620,683
2035 No Build	40	4,028	827	7	88	27	938,132
2035 Project Alterative	29	3,543	357	6	79	19	771,182
	C4BHSR - HSR: Emissions Tons per year						
2013	226	7,014	1,529	12	46	24	597,632
2035 No Build	41	4,042	938	7	88	28	957,194
2035 Project Alterative	22	3,090	132	5	69	15	901,358
	C4C HSR - HSR: Emissions Tons per year						
2013	225	6,972	1,521	12	46	24	594,172
2035 No Build	44	4,112	1,050	8	89	29	987,791
2035 Project Alterative	23	3,137	134	5	70	15	936,978

Evaluation Years	VOC	CO	NOx	SO2	PM10	PM2.5	CO2
	S4HRSR - SRSR - Electric : Emissions Tons per year						
2013	485	16,236	2,521	24	75	31	1,226,662
2035 No Build	83	12,945	442	16	261	57	2,408,974
2035 Project Alterative	82	12,919	438	17	260	57	2,976,596
	S4HRSR - SRSR - Diesel : Emissions Tons per year						
2013	485	16,236	2,521	24	75	31	1,226,662
2035 No Build	83	12,945	442	16	261	57	2,408,974
2035 Project Alterative	86	13,049	599	17	262	60	2,449,934
	S6 HRSR - HRSR- Electric : Emissions Tons per year						
2013	97	3,232	516	5	16	7	246,172
2035 No Build	8	1,307	47	2	27	6	246,083
2035 Project Alterative	8	1,250	45	2	25	6	437,734
	S6 HRSR - HRSR- Diesel : Emissions Tons per year						
2013	97	3,232	516	5	16	7	246,172
2035 No Build	8	1,307	47	2	27	6	246,083
2035 Project Alterative	9	1,296	102	2	26	6	253,037
	S6HSR - HSR: Emissions Tons per year						
2013	97	3,232	516	5	16	7	246,172
2035 No Build	8	1,307	47	2	27	6	246,083
2035 Project Alterative	8	1,230	45	2	25	6	343,919

Table A-1 - Passenger Vehicle Emissions 2013 and 2035 (tons/yr)

Central Section

	Scenario	VMT[1] (mi)	VOC	CO	NOx	SO2	PM10	PM2.5	CO2	CH4	CO2e
C4Ahsr	Auto Existing 2013	1,348,987,339.03	209.04	6,890.87	1,208.80	11.18	36.12	15.43	566,737.36	9.76	566,978
	Auto No Build 2035	2,742,367,985.49	24.07	3,390.53	136.90	4.75	75.25	15.93	702,130.61	4.85	702,252
	Auto C4A True High 2035	2,507,423,895.17	22.01	3,100.06	125.17	4.35	68.80	14.56	641,977.69	4.44	642,088
C4Ah	Auto Existing 2013	1,415,866,197.29	219.41	7,232.50	1,268.73	11.73	37.91	16.19	594,834.55	10.25	595,087
	Auto No Build 2035	2,811,060,424.80	24.67	3,475.46	140.32	4.87	77.13	16.33	719,717.98	4.98	719,842
	Auto C4A Higher 2035	2,722,809,840.23	23.90	3,366.35	135.92	4.72	74.71	15.81	697,123.12	4.82	697,243
C4Bhsr	Auto Existing 2013	1,361,000,146.42	210.91	6,952.24	1,219.57	11.28	36.44	15.57	571,784.19	9.85	572,027
	Auto No Build 2035	2,748,517,875.66	24.12	3,398.14	137.20	4.76	75.42	15.96	703,705.17	4.87	703,826
	Auto C4B True High 2035	2,496,018,504.59	21.91	3,085.96	124.60	4.33	68.49	14.50	639,057.56	4.42	639,168
C4Chsr	Auto Existing 2013	1,352,763,459.19	209.63	6,910.16	1,212.19	11.21	36.22	15.47	568,323.79	9.79	568,565
	Auto No Build 2035	2,731,030,269.46	23.97	3,376.52	136.33	4.73	74.94	15.86	699,227.80	4.83	699,348
	Auto C4C True High 2035	2,533,463,242.17	22.24	3,132.25	126.47	4.39	69.52	14.71	648,644.56	4.48	648,756

Northern Section

	Scenario	VMT (mi)	VOC	CO	NOx	SO2	PM10	PM2.5	CO2	CH4	CO2e
N4Ac	Auto Existing 2013	1,303,329,271.33	206.38	7,078.95	1,201.45	10.76	37.77	17.45	545,734.47	9.29	545,964
	Auto No Build 2035	2,047,593,985.09	17.16	2,736.19	105.47	3.54	56.76	12.40	522,403.03	3.49	522,489
	Auto N4A 2035	2,035,630,280.60	17.06	2,720.20	104.85	3.52	56.42	12.32	519,350.73	3.47	519,436

Southern Section

	Scenario	VMT (mi)	VOC	CO	NOx	SO2	PM10	PM2.5	CO2	CH4	CO2e
S4h	Auto Existing 2013	2,895,896,201.35	481.53	16,222.32	2,465.25	24.02	71.79	28.03	1,218,125.96	21.68	1,218,661
	Auto No Build 2035	9,364,781,442.91	82.28	12,943.27	435.12	16.22	260.21	57.26	2,400,800.12	16.63	2,401,213
	Auto S4 Higher 2035	9,346,313,853.53	82.12	12,917.74	434.26	16.19	259.69	57.15	2,396,065.68	16.59	2,396,478
S6h	Auto Existing 2013	575,850,908.97	95.75	3,225.82	490.22	4.78	14.27	5.57	242,225.17	4.31	242,331
	Auto No Build 2035	945,152,133.94	8.30	1,306.32	43.91	1.64	26.26	5.78	242,303.72	1.68	242,345
	Auto S6 Higher 2035	903,756,611.46	7.94	1,249.10	41.99	1.57	25.11	5.53	231,691.36	1.60	231,731
S6hsr	Auto Existing 2013	575,850,908.97	95.75	3,225.82	490.22	4.78	14.27	5.57	242,225.17	4.31	242,331
	Auto No Build 2035	945,152,133.94	8.30	1,306.32	43.91	1.64	26.26	5.78	242,303.72	1.68	242,345
	Auto S6 True High 2035	889,331,732.36	7.81	1,229.16	41.32	1.54	24.71	5.44	227,993.33	1.58	228,033

Notes:

[1] VMT as defined in the SDG TOPRS Values 20160301: TOPRS Phase 3, PMT, VMT, Mode Share, dated March 01, 2016.

Emission factors from MOVES model, for passenger vehicles and buses, for scenario year 2013 (56 mph) and 2035 (48 mph), for Canadian County, OK, Dallas County, TX, and Cameron County, TX. Canadian County is associated with the Norhtern Section, Dallas County is associated with the Central Section, and Cameron County is associated with the Southern Section.

Table A-2 - Intercity Bus Emissions 2013 and 2035 (tons/yr)

Central Section

	Scenario	VMT (mi)[1]	VOC	CO	NOx	SO2	PM10	PM2.5	CO2	CH4	CO2e
C4Ahsr	Bus Existing 2013	4,624,200.00	2.87	13.09	55.90	0.07	2.78	2.35	8,030.42	0.10	8,032.92
	Bus No Build 2035	4,624,200.00	0.26	1.91	6.61	0.06	0.65	0.22	7,689.20	0.21	7,694.53
	Bus C4A True High 2035	4,624,200.00	0.26	1.91	6.61	0.06	0.65	0.22	7,689.20	0.21	7,694.53
C4Ah	Bus Existing 2013	4,624,200.00	2.87	13.09	55.90	0.07	2.78	2.35	8,030.42	0.10	8,032.92
	Bus No Build 2035	4,624,200.00	0.26	1.91	6.61	0.06	0.65	0.22	7,689.20	0.21	7,694.53
	Bus C4A Higher 2035	4,624,200.00	0.26	1.91	6.61	0.06	0.65	0.22	7,689.20	0.21	7,694.53
C4Bhsr	Bus Existing 2013	4,624,200.00	2.87	13.09	55.90	0.07	2.78	2.35	8,030.42	0.10	8,032.92
	Bus No Build 2035	4,624,200.00	0.26	1.91	6.61	0.06	0.65	0.22	7,689.20	0.21	7,694.53
	Bus C4B True High 2035	4,624,200.00	0.26	1.91	6.61	0.06	0.65	0.22	7,689.20	0.21	7,694.53
C4Chsr	Bus Existing 2013	4,624,200.00	2.87	13.09	55.90	0.07	2.78	2.35	8,030.42	0.10	8,032.92
	Bus No Build 2035	4,624,200.00	0.26	1.91	6.61	0.06	0.65	0.22	7,689.20	0.21	7,694.53
	Bus C4C True High 2035	4,624,200.00	0.26	1.91	6.61	0.06	0.65	0.22	7,689.20	0.21	7,694.53

Northern Section

	Scenario	VMT (mi)[1]	VOC	CO	NOx	SO2	PM10	PM2.5	CO2	CH4	CO2e
N4Ac	Bus Existing 2013	776,412.00	0.48	2.20	9.46	0.01	0.47	0.39	1,343.80	0.02	1,344.22
	Bus No Build 2035	776,412.00	0.04	0.32	1.12	0.01	0.11	0.04	1,286.38	0.04	1,287.28
	Bus N4A 2035	776,412.00	0.04	0.32	1.12	0.01	0.11	0.04	1,286.38	0.04	1,287.28

Southern Section

	Scenario	VMT (mi)[1]	VOC	CO	NOx	SO2	PM10	PM2.5	CO2	CH4	CO2e
S4h	Bus Existing 2013	4,909,200.00	3.05	13.90	56.07	0.07	2.95	2.49	8,535.96	0.11	8,538.61
	Bus No Build 2035	4,909,200.00	0.27	2.03	6.63	0.07	0.69	0.24	8,174.01	0.23	8,179.66
	Bus S4 Higher 2035	4,909,200.00	0.27	2.03	6.63	0.07	0.69	0.24	8,174.01	0.23	8,179.66
S6h	Bus Existing 2013	2,269,800.00	1.41	6.43	25.92	0.03	1.36	1.15	3,946.65	0.05	3,947.88
	Bus No Build 2035	2,269,800.00	0.13	0.94	3.07	0.03	0.32	0.11	3,779.31	0.10	3,781.92
	Bus S6 Higher 2035	2,269,800.00	0.13	0.94	3.07	0.03	0.32	0.11	3,779.31	0.10	3,781.92
S6hsr	Bus Existing 2013	2,269,800.00	1.41	6.43	25.92	0.03	1.36	1.15	3,946.65	0.05	3,947.88
	Bus No Build 2035	2,269,800.00	0.13	0.94	3.07	0.03	0.32	0.11	3,779.31	0.10	3,781.92
	Bus S6 True High 2035	2,269,800.00	0.13	0.94	3.07	0.03	0.32	0.11	3,779.31	0.10	3,781.92

Notes:

[1] VMT as defined in the SDG TOPRS Values 20160301: TOPRS Phase 3, PMT, VMT, Mode Share, dated March 01, 2016.

Emission factors from MOVES model, for passenger vehicles and buses, for scenario year 2013 (56 mph) and 2035 (48 mph), for Canadian County, OK (northern region), Dallas County, TX (central region), and Cameron County, TX (southern region).

Table A-3 - Airplane Emissions 2013 and 2035 (tons/yr) [1]

Central Section

	Scenario	Airplanes/Day[2]	VOC	CO	NOx	SO2	PM10	PM2.5	CO2e
C4Ahsr	Airplane Existing 2013	118	0.24	2.61	0.85	0.12	0.02	0.02	280.65
	Airplane No Build 2035	118	0.22	2.04	0.79	0.12	0.02	0.02	279.88
	Airplane C4A True High 2035	118	0.22	2.04	0.79	0.12	0.02	0.02	279.88
C4Ah	Airplane Existing 2013	118	0.24	2.61	0.85	0.12	0.02	0.02	280.65
	Airplane No Build 2035	118	0.22	2.04	0.79	0.12	0.02	0.02	279.88
	Airplane C4A Higher 2035	118	0.22	2.04	0.79	0.12	0.02	0.02	279.88
C4Bhsr	Airplane Existing 2013	118	0.24	2.61	0.85	0.12	0.02	0.02	280.65
	Airplane No Build 2035	118	0.22	2.04	0.79	0.12	0.02	0.02	279.88
	Airplane C4B True High 2035	118	0.22	2.04	0.79	0.12	0.02	0.02	279.88
C4Chsr	Airplane Existing 2013	118	0.24	2.61	0.85	0.12	0.02	0.02	280.65
	Airplane No Build 2035	118	0.22	2.04	0.79	0.12	0.02	0.02	279.88
	Airplane C4C True High 2035	118	0.22	2.04	0.79	0.12	0.02	0.02	279.88

Northern Section

	Scenario	Airplanes/Day[2]	VOC	CO	NOx	SO2	PM10	PM2.5	CO2e
N4Ac	Airplane Existing 2013	8	0.02	0.18	0.06	0.01	0.00	0.00	19.03
	Airplane No Build 2035	8	0.02	0.14	0.05	0.01	0.00	0.00	18.98
	Airplane N4A 2035	8	0.02	0.14	0.05	0.01	0.00	0.00	18.98

Southern Section

	Scenario	Airplanes/Day[2]	VOC	CO	NOx	SO2	PM10	PM2.5	CO2e
S4h	Airplane Existing 2013	-	-	-	-	-	-	-	-
	Airplane No Build 2035	-	-	-	-	-	-	-	-
	Airplane S4 Higher 2035	-	-	-	-	-	-	-	-
S6h	Airplane Existing 2013	-	-	-	-	-	-	-	-
	Airplane No Build 2035	-	-	-	-	-	-	-	-
	Airplane S6 Higher 2035	-	-	-	-	-	-	-	-
S6hsr	Airplane Existing 2013	-	-	-	-	-	-	-	-
	Airplane No Build 2035	-	-	-	-	-	-	-	-
	Airplane S6 True High 2035	-	-	-	-	-	-	-	-

Notes:

[1] Airplane emissions include approach, climb out, takeoff, and taxi. It does not include emissions at altitude.

[2] Airplanes per day as defined in the SDG TOPRS Values 20160301: TOPRS Phase 3, LOS tabs, dated March 01, 2016.

[3] No airplanes were shown in the southern region, based on the SDG TOPS LOS tabs.

Emission factors of criterial pollutants are based on default values for a Boeing 737-300 series airplane, from the EDMS model. Emissions include airplanes, GSE, and APUs.

GHG emission factor from World Resources Institute (2008). GHG Protocol tool for mobile combustion. Version 2.0. Jet Fuel. http://www.ghgprotocol.org/calculation-tools/service-sector

Fuel type source: REDCOM, Commercial Aviation Fuels, TARDEC. December 2011, JP8 Fuels.

Table A-4 - Electric Locomotive Emissions 2013 and 2035 (tons/yr)

Central Section

	Scenario	Power (MW)[1]	1-Way Trains/day [2]	Minutes	Increased MWh	VOC	CO	NOx	SO2	PM10	PM2.5	CO2	CH4	CO2e	N2O
C4Ahsr	Rail Existing 2013	9.60	2	605	194	0.01	0.16	0.15	0.24	0.02	0.01	1,211,576.68	17,701.33	5,548,763.40	13,069.31
	Rail No Build 2035	9.60	32	605	3,098	0.20	2.52	2.42	3.85	0.28	0.22	1,211,576.68	17,701.33	5,548,763.40	13,069.31
	Rail C4A True High 2035	9.60	32	115	589	0.04	0.48	0.46	0.73	0.05	0.04	230,299.70	3,364.72	1,054,723.62	2,484.25
C4Ah	Rail Existing 2013	9.60	2	605	194	0.01	0.16	0.15	0.24	0.02	0.01	1,211,576.68	17,701.33	5,548,763.40	13,069.31
	Rail No Build 2035	9.60	24	605	2,323	0.15	1.89	1.82	2.88	0.21	0.16	1,211,576.68	17,701.33	5,548,763.40	13,069.31
	Rail C4A Higher 2035	9.60	24	190	730	0.05	0.59	0.57	0.91	0.07	0.05	380,495.16	5,559.10	1,742,586.85	4,104.41
C4Bhsr	Rail Existing 2013	9.60	2	605	194	0.01	0.16	0.15	0.24	0.02	0.01	1,211,576.68	17,701.33	5,548,763.40	13,069.31
	Rail No Build 2035	9.60	28	605	2,710	0.18	2.21	2.12	3.37	0.25	0.19	1,211,576.68	17,701.33	5,548,763.40	13,069.31
	Rail C4B True High 2035	9.60	28	127	569	0.04	0.46	0.45	0.71	0.05	0.04	254,330.97	3,715.82	1,164,781.74	2,743.47
C4Chsr	Rail Existing 2013	9.60	2	605	194	0.01	0.16	0.15	0.24	0.02	0.01	1,211,576.68	17,701.33	5,548,763.40	13,069.31
	Rail No Build 2035	9.60	32	605	3,098	0.20	2.52	2.42	3.85	0.28	0.22	1,211,576.68	17,701.33	5,548,763.40	13,069.31
	Rail C4C True High 2035	9.60	32	140	717	0.05	0.58	0.56	0.89	0.07	0.05	280,364.85	4,096.18	1,284,011.37	3,024.30

Northern Section

	Scenario	Power (MW)[1]	1-Way Trains/day [2]	Minutes	Increased MWh	VOC	CO	NOx	SO2	PM10	PM2.5	CO2	CH4	CO2e	N2O
N4Ac	Rail Existing 2013	9.60	12	418	803	0.05	0.26	0.52	0.32	0.04	0.03	1,126,794.14	17,392.98	5,921,976.48	14,632.07
	Rail No Build 2035	9.60	12	418	803	0.05	0.26	0.52	0.32	0.04	0.03	1,126,794.14	17,392.98	5,921,976.48	14,632.07
	Rail N4A 2035	9.60	12	266	511	0.03	0.17	0.33	0.20	0.02	0.02	717,050.82	11,068.26	3,768,530.49	9,311.32

Southern Section

	Scenario	Power (MW)[1]	1-Way Trains/day [2]	Minutes	Increased MWh	VOC	CO	NOx	SO2	PM10	PM2.5	CO2	CH4	CO2e	N2O
S4h	Rail Existing 2013	9.60	-	-	-	-	-	-	-	-	-	-	-	-	-
	Rail No Build 2035	9.60	-	-	-	-	-	-	-	-	-	-	-	-	-
	Rail S4 Higher 2035	9.60	12	288	553	0.04	0.45	0.43	0.69	0.05	0.04	576,751	8,426.42	2,641,394.81	6,221.42
S6h	Rail Existing 2013	9.60	-	-	-	-	-	-	-	-	-	-	-	-	-
	Rail No Build 2035	9.60	-	-	-	-	-	-	-	-	-	-	-	-	-
	Rail S6 Higher 2035	9.60	12	101	194	0.01	0.16	0.15	0.24	0.02	0.01	202,263	2,955.10	926,322.49	2,181.82
S6hsr	Rail Existing 2013	9.60	-	-	-	-	-	-	-	-	-	-	-	-	-
	Rail No Build 2035	9.60	-	-	-	-	-	-	-	-	-	-	-	-	-
	Rail S6 True High 2035	9.60	24	56	215	0.01	0.18	0.17	0.27	0.02	0.02	112,146	1,638.47	513,604.55	1,209.72

Notes:

[1] Electric-powered train set rating is based on email provided by Bruce Horowitz, email dated 2/28/16. "Based on Bombardier's current European UIC Standard HSR Distributed Power Trains, comparable to the type of train we are proposing for TOPRS electric true HSR service scenarios in the central section, and the single true HSR scenario in the southern section, the power for our proposed fixed consist 8-car trainset is 9600 KwH or roughly 10 MW."

[2] Trains per day is based on the TOPRS schedules in Service Development Plan: Narrative on Initial Service Schedule and Operating Assumptions Texas-Oklahoma Passenger Rail Study – Service-Level EIS Phase, dated Aug 21, 2014.

Criteria Pollutant Emission Factors are from the most recent NEI State summary: National Emissions Inventory (NEI) by State, 2011. Emission Inventory from combustion sources are represenatative of Power Production by State. http://www3.epa.gov/cgi-bin/broker?_service=data&_debug=0&_program=dataprog.state_1.sas&pol=PM25_PRI&stfips=40

GHG Emission factors obtained from eGRID2012 Summary Tables. 2012 eGrid Subregion Resource Mix, Data from 2012. Data not avaliable for 2011. https://www.epa.gov/sites/production/files/2015-10/documents/egrid2012_summarytables_0.pdf

Table A-5 - Diesel Locomotive Emissions 2013 and 2035 (tons/yr)

Central Section

	Scenario	Number of Trains[1]	Travel Time[2] (min/day)	VOC	CO	NOx	SO2	PM10	PM2.5	CO2
C4Ahsr	Rail Existing 2013	2	605	11.84	45.70	252.31	0.16	6.69	6.49	17,537
	Rail No Build 2035	32	605	19.22	731.17	906.27	2.58	13.73	13.32	280,594
	Rail C4A True High 2035	32	115	3.65	138.98	172.27	0.49	2.61	2.53	53,336
C4Ah	Rail Existing 2013	2	605	11.84	45.70	252.31	0.16	6.69	6.49	17,537
	Rail No Build 2035	24	605	14.42	548.37	679.70	1.93	10.30	9.99	210,445
	Rail C4A Higher 2035	24	190	4.53	172.22	213.46	0.61	3.23	3.14	66,090
C4Bhsr	Rail Existing 2013	2	605	11.84	45.70	252.31	0.16	6.69	6.49	17,537
	Rail No Build 2035	28	605	16.82	639.77	792.98	2.26	12.01	11.65	245,520
	Rail C4B True High 2035	28	127	3.53	134.30	166.46	0.47	2.52	2.45	51,539
C4Chsr	Rail Existing 2013	2	605	11.84	45.70	252.31	0.16	6.69	6.49	17,537
	Rail No Build 2035	32	605	19.22	731.17	906.27	2.58	13.73	13.32	280,594
	Rail C4C True High 2035	32	140	4.45	169.20	209.71	0.60	3.18	3.08	64,931

Northern Section

	Scenario	Number of Trains[1]	Travel Time[2] (min/day)	VOC	CO	NOx	SO2	PM10	PM2.5	CO2
N4Ac	Rail Existing 2013	12	418	49.10	189.44	1,045.95	0.67	27.75	26.92	72,699.31
	Rail No Build 2035	12	418	4.98	189.44	234.81	0.67	3.56	3.45	72,699.31
	Rail N4A 2035	12	266	3.17	120.55	149.42	0.43	2.26	2.20	46,263.20

Southern Section

	Scenario	Number of Trains[1]	Travel Time[2] (min/day)	VOC	CO	NOx	SO2	PM10	PM2.5	CO2
S4h	Rail Existing 2013	0	-	-	-	-	-	-	-	-
	Rail No Build 2035	0	-	-	-	-	-	-	-	-
	Rail S4 Higher 2035	12	288	3.43	130.52	162	0.46	2.45	2.38	50,089
S6h	Rail Existing 2013	0	-	-	-	-	-	-	-	-
	Rail No Build 2035	0	-	-	-	-	-	-	-	-
	Rail S6 Higher 2035	12	101	1.20	45.77	57	0.16	0.86	0.83	17,566
S6hsr	Rail Existing 2013	0	-	-	-	-	-	-	-	-
	Rail No Build 2035	0	-	-	-	-	-	-	-	-
	Rail S6 True High 2035	24	56	1.33	50.76	63	0.18	0.95	0.92	19,479

Notes:

[1] Number of trains for No build was set equal to number of trains for bulid alternative to account for population growth, except for in the Souther Section where there is no current rail

[2] Travel time for northern route based on time from Okalhoma city to Dallas-Fort Worth, central cention from Dallas to San Antonio, and Southern Section based on s6 - San Antonio to Laredo, S4
Emission factors are based on Office of Transportation and Air Quality, EPA-420-F-09-025, dated April 2009. PM2.5 was estimated at 97% of PM10 (Page 4, other pollutants). Fuel consumption of 20.8 hp-hr/gal, for Passenger Locomotives is from Table 3 of this document and was used to convert the emission factors.

Diesel Train horsepower provided by Bruce Horowitz, email dated 2/25/16. The High-Performance Diesel Loco HP, based on the currently contracted (and under construction)
Siemens Passenger Caltrans/IDOT 125 model: 4,400 HP

Hourly schedules as defined in the SDG TOPRS Values 20160301: TOPRS Phase 3, TravelTime tab, dated March 01, 2016.