Crosstown Boulevard
Air Quality Technical Memorandum

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Summary of Findings

The Crosstown Boulevard Project is located in Oklahoma County, which meets all of the National Ambient Air Quality Standards (NAAQS). The project is not expected to affect regional air quality levels, as it would not affect regional vehicle miles traveled (VMT). Per the Federal Highway Administration's (FHWA's) Interim Guidance Update on Air Toxic Analysis in NEPA (FHWA 2012), the project does not have the potential for meaningful mobile source air toxic (MSAT) effects, as it will not have a meaningful impact on traffic volumes or vehicle mix.

Several intersections in the study area are predicted to have poor level-of-service (LOS) under the project alternatives in both 2015 and 2040; these intersections do have the potential for elevated local pollutant emissions of carbon monoxide (CO). Alternative A would have the least number of intersections with poor LOS and would therefore have less potential for elevated CO levels. Alternative D would have the most number of intersections with poor LOS and would therefore have the greatest potential for elevated CO levels. Based on the results of the microscale CO analysis of the highest volume intersection affected by the project, none of the alternatives are predicted to cause or exacerbate a violation of the NAAQS for CO.

1.0 Introduction

Air pollution is a general term that refers to one or more chemical substances that degrade the quality of the atmosphere. Individual air pollutants degrade the atmosphere by reducing visibility; they are also responsible for damaging property, reducing the productivity or vigor of crops or natural vegetation, and harming human or animal health.

The purpose of this technical memorandum is to document the process used to identify potential air quality impacts associated with the Crosstown Boulevard. Additionally, this *Air Quality Technical Memorandum* was developed to support the analysis completed for the Environmental Assessment for the Crosstown Boulevard. The Environmental Assessment will include a summary of this technical report, which will be included as an appendix to the document when it is developed.

1.1 Air Quality Standards

1.1.1 Clean Air Act Amendments of 1990

The Clean Air Act (CAA), the Clean Air Act Amendments (CAAA) of 1990, and the Final Transportation Conformity Rule [40 Code of Federal Regulations Parts 51 and 93] direct the U.S. Environmental Protection Agency (USEPA) to implement environmental policies and regulations that will ensure acceptable levels of air quality.

The CAA and the Final Transportation Conformity Rule affect the funding and approval of proposed transportation projects. According to CAA Title I, Section 176 (c) 2:

> *No federal agency may approve, accept or fund any transportation plan, program or project unless such plan, program or project has been found to conform to any applicable State Implementation Plan (SIP) in effect under this act.*

According to section 176(c)2(A) of the CAA, conformity to an implementation plan means eliminating or reducing the severity and number of violations of the NAAQS and achieving expeditious attainment of such standards, and that such activities will not:

- Cause or contribute to any new violation of any NAAQS in any area
- Increase the frequency or severity of any existing violation of any NAAQS in any area
- Delay timely attainment of any NAAQS or any required interim emission reductions or other milestones in any area

1.1.2 National and State Ambient Air Quality Standards

As required by the CAA, NAAQS have been established for six major air pollutants (USEPA 2013a). These pollutants, known as criteria pollutants, are carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), particulate matter (PM), sulfur dioxide (SO_2), and lead (Pb).

The federal standards are summarized in Table 1. The "primary" standards have been established to protect public health. The "secondary" standards are intended to protect the nation's welfare, and they account for air pollutant effects on soil, water, visibility, materials, vegetation, and other aspects of general welfare.

Table 1. National Ambient Air Quality Standards

Pollutant		Primary/Secondary	Averaging Time	Level	Form
Carbon Monoxide		Primary	8-hour	9 ppm	Not to be exceeded more than once per year
			1-hour	35 ppm	
Lead		Primary and secondary	Rolling three month average	0.15 µg/m³ (1)	Not to be exceeded
Nitrogen Dioxide		Primary	1-hour	100 ppb	98th percentile, averaged over 3 years
		Primary and secondary	Annual	53 ppb (2)	Annual mean
Ozone		Primary and secondary	8-hour	0.075 ppm (3)	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years
Particle Pollution	$PM_{2.5}$	Primary	Annual	12 µg/m³	Annual mean, averaged over 3 years
		Secondary	Annual	15 µg/m³	Annual mean, averaged over 3 years
		Primary and secondary	24-hour	35 µg/m³	98th percentile, averaged over 3 years
	PM_{10}	Primary and secondary	24-hour	150 µg/m³	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide		Primary	1-hour	75 ppb (4)	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

Source: USEPA, http://www.epa.gov/air/criteria.html, accessed February 14, 2014

Notes: PM = particulate matter; ppb = parts per billion; ppm = parts per million; µg/m³ = micrograms per cubic meter

(1) 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.

(2) 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.

(3) Final rule signed March 12, 2008. The 1997 ozone standard (0.08 ppm, annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years) and related implementation rules remain in place. In 1997, EPA revoked the 1-hour ozone standard (0.12 ppm, not to be exceeded more than once per year) in all areas, although some areas have continued obligations under that standard ("anti-backsliding"). The 1-hour ozone standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is less than or equal to 1.

(4) 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.

1.2 Criteria Pollutants and Effects

As previously described, pollutants that have established national standards are referred to as “criteria pollutants.” The sources of these pollutants, their effects on human health and the nation's welfare, and their final deposition in the atmosphere vary considerably. A brief description of each pollutant is provided below.

1.2.1 Ozone

O_3 is a colorless toxic gas. O_3 is found in both the Earth’s upper and lower atmospheric levels. In the upper atmosphere, O_3 is a naturally occurring gas that helps to prevent the sun’s harmful ultraviolet rays from reaching the Earth. In the lower layer of the atmosphere, the formation of O_3 is mostly the result of human activity, although O_3 also occurs because of hydrocarbons released by plants and soil. O_3 is not directly emitted into the atmosphere; it forms in the lower atmosphere through a chemical reaction between hydrocarbons (HC), also referred to as volatile organic compounds (VOCs), and nitrogen oxides (NO_x), which are emitted from industrial sources and from automobiles. As shown in Figure 1 and Figure 2, mobile sources are the primary sources of VOCs and NO_x in Oklahoma County. Substantial O_3 formations generally require a stable atmosphere with strong sunlight; thus, high levels of O_3 are generally a concern in summer. O_3 is the main ingredient of smog. O_3 enters the bloodstream through the respiratory system and interferes with the transfer of oxygen, depriving sensitive tissues in the heart and brain of oxygen. O_3 also damages vegetation by inhibiting its growth.

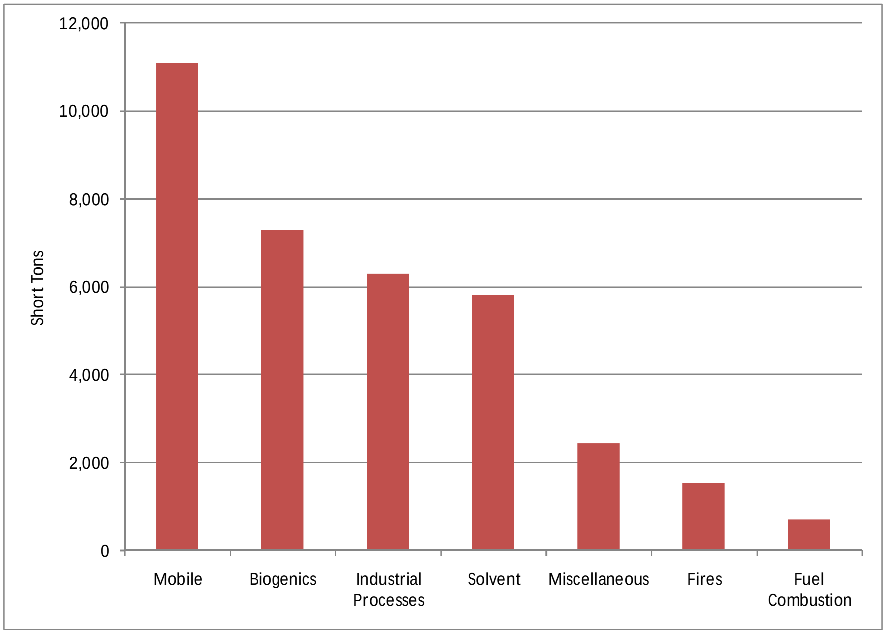
1.2.2 Carbon Monoxide

CO, a colorless gas, interferes with the transfer of oxygen to the brain. CO is emitted almost exclusively from the incomplete combustion of fossil fuels. As shown in Figure 3, mobile sources are the primary sources of CO in Oklahoma County. Prolonged exposure to high levels of CO can cause headaches, drowsiness, loss of equilibrium, or heart disease. CO concentrations can vary greatly over relatively short distances. Relatively high concentrations of CO are typically found near congested intersections, along heavily used roadways carrying slow-moving traffic, and in areas where atmospheric dispersion is inhibited by urban “street canyon” conditions. Consequently, CO concentrations must be predicted on a localized, or microscale, basis.

1.2.3 Particulate Matter

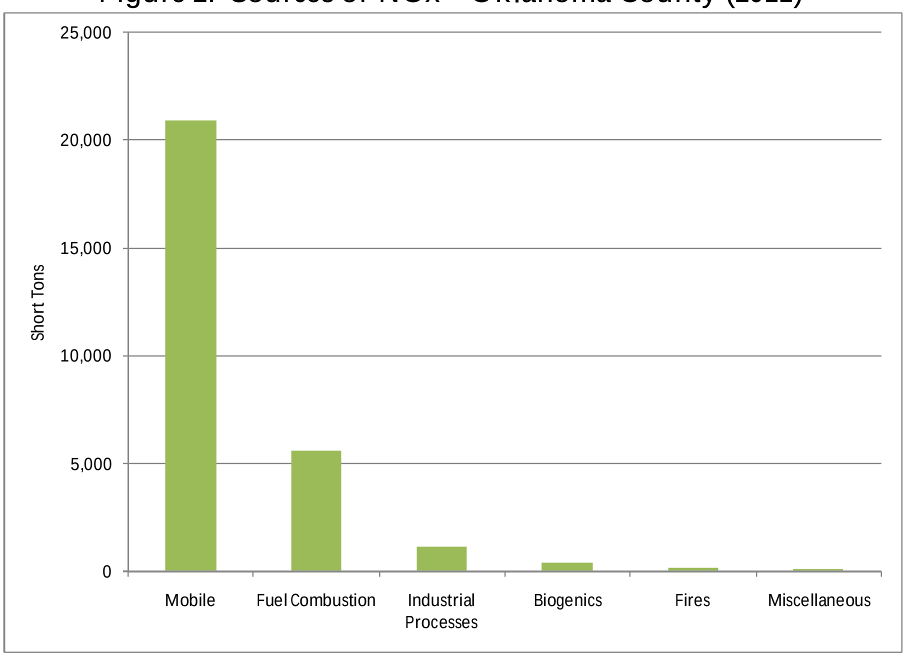
Particulate pollution is composed of solid particles or liquid droplets that are small enough to remain suspended in the air. In general, particulate pollution can include dust, soot, and smoke; these can be irritating but usually are not poisonous. Particulate pollution also can include bits of solid or liquid substances that can be highly toxic. Of particular concern are those particles that are smaller than, or equal to, 10 microns (PM_{10}) and 2.5 microns ($PM_{2.5}$) in size.

Figure 1. Sources of VOCs – Oklahoma County (2011)



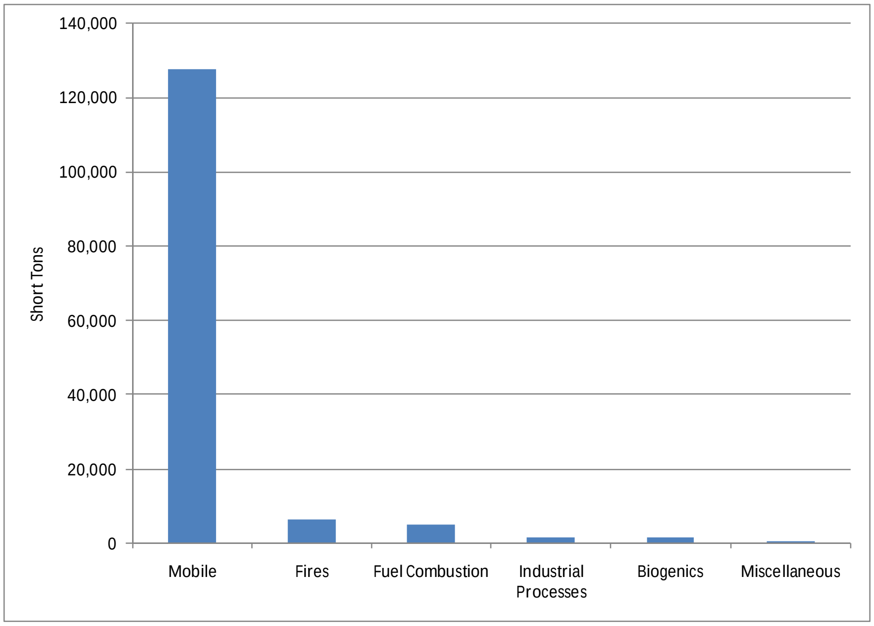
Source: USEPA, http://www.epa.gov/cgi-bin/broker?_service=data&_debug=0&_program=dataprog.state_1 .sas&pol=VOC&stfips=40, accessed April 21, 2014

Figure 2. Sources of NOx – Oklahoma County (2011)



Source: USEPA, http://www.epa.gov/cgi-bin/broker?_service=data&_debug=0&_program=dataprog.state_1. sas&pol=NOX&stfips=40, accessed April 21, 2014

Figure 3. Sources of CO – Oklahoma County (2011)

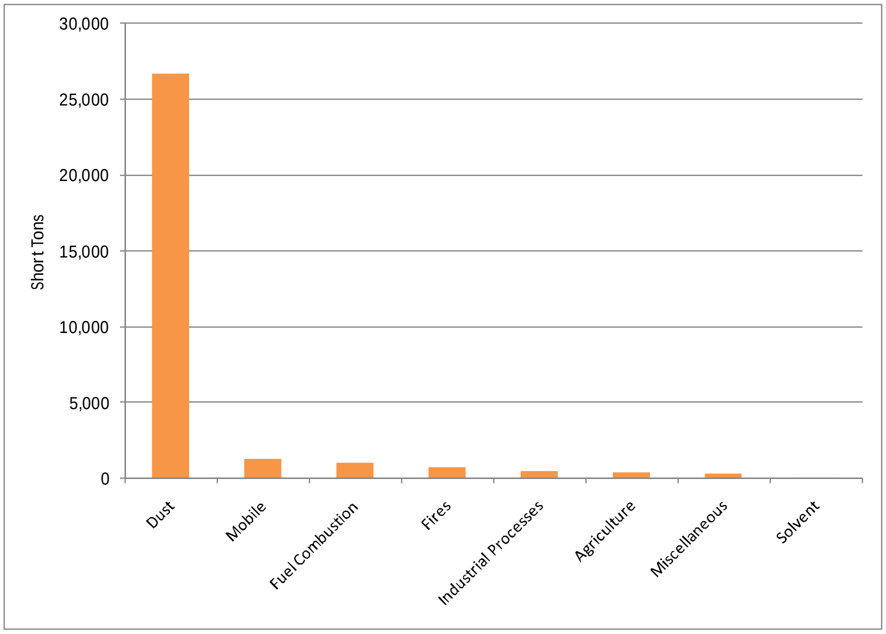


Source: USEPA,http://www.epa.gov/cgi-bin/broker?_service=data&_debug=0&_program=dataprog.state_1. sas&pol=CO&stfips=40, accessed April 21, 2014

PM_{10}

PM_{10} refers to particulate matter less than 10 microns in diameter, about one-seventh the thickness of a human hair. Particulate matter pollution consists of very small liquid and solid particles floating in the air, which can include smoke, soot, dust, salts, acids, and metals. Particulate matter also forms when industry and gases emitted from motor vehicles undergo chemical reactions in the atmosphere. Major sources of PM_{10} include motor vehicles; wood-burning stoves and fireplaces; dust from construction, landfills, and agriculture; wildfires and brush/waste burning; industrial sources; windblown dust from open lands; and atmospheric chemical and photochemical reactions. Suspended particulates produce haze and reduce visibility. Additionally, PM_{10} poses a greater health risk than larger- sized particles. When inhaled, these tiny particles can penetrate the human respiratory system's natural defenses and damage the respiratory tract. PM_{10} can increase the number and severity of asthma attacks, cause or aggravate bronchitis and other lung diseases, and reduce the body's ability to fight infections. Data collected through numerous nationwide studies indicate that most PM_{10} comes from fugitive dust, wind erosion, and agricultural and forestry sources. Figure 4 shows the primary sources of PM_{10} in Oklahoma County.

Figure 4. Sources of PM_{10} – Oklahoma County (2011)



Source: USEPA, http://www.epa.gov/cgi-bin/broker?_service=data&_debug=0&_program=dataprog.state_1. sas&pol=PM10_PRI&stfips=40, accessed April 21, 2014

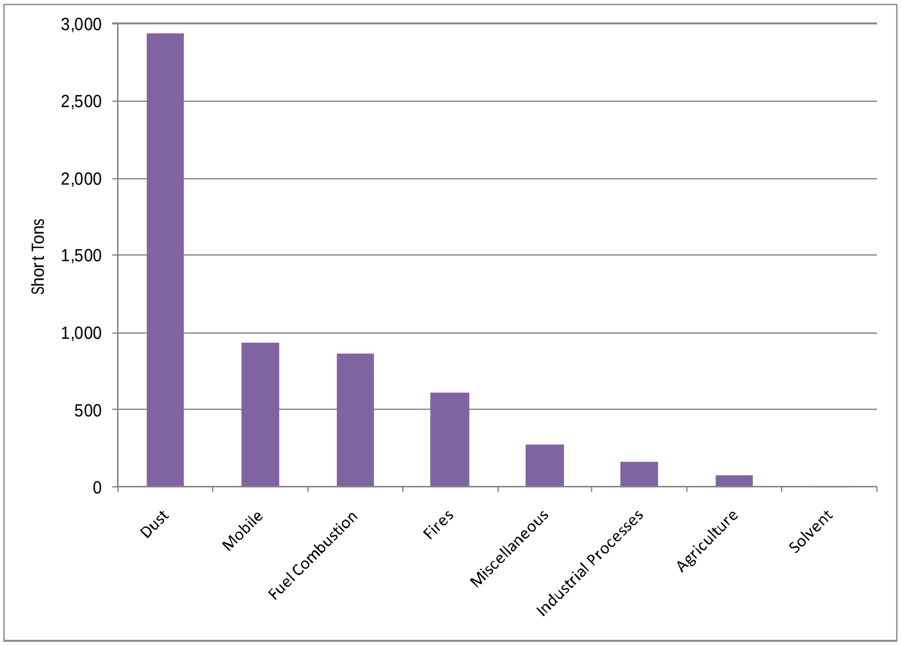
$PM_{2.5}$

A small portion of particulate matter is the product of fuel combustion processes. In the case of $PM_{2.5}$, the combustion of fossil fuels accounts for a significant portion of this pollutant. Figure 5 shows the primary sources of $PM_{2.5}$ in Oklahoma County. The main health effect of airborne particulate matter is on the respiratory system. $PM_{2.5}$ refers to particulates that are 2.5 microns or less in diameter, roughly 1-28th the diameter of a human hair. $PM_{2.5}$ results from fuel combustion (from motor vehicles, power generation, and industrial facilities), residential fireplaces, and wood stoves. In addition, $PM_{2.5}$ can be formed in the atmosphere from gases such as sulfur dioxide, nitrogen oxides, and volatile organic compounds. As with PM_{10}, $PM_{2.5}$ can penetrate the human respiratory system's natural defenses and damage the respiratory tract when inhaled. Whereas particles 2.5 to 10 microns in diameter tend to collect in the upper portion of the respiratory system, particles 2.5 microns or less are so tiny that they can penetrate deeper into the lungs and damage lung tissues.

1.2.4 Nitrogen Dioxide

NO_2 is a brownish gas that irritates the lungs. It can cause breathing difficulties at high concentrations. As with O_3, NO_2 is not directly emitted but is formed through a reaction between nitric oxide (NO) and atmospheric oxygen. NO and NO_2 are collectively referred to as NO_x and are major contributors to ozone formation. NO_2 also contributes to the formation of PM_{10}. At atmospheric concentration, NO_2 is only potentially irritating. In high

Figure 5. Sources of $PM_{2.5}$ – Oklahoma County (2011)



Source: EPA, http://www.epa.gov/cgi-bin/broker?_service=data&_debug=0&_program=dataprog.state_1.sas&pol=PM25_PRI&stfips=40, accessed April 21, 2014

concentrations, the result is a brownish-red cast to the atmosphere and reduced visibility. There is some indication of a relationship between NO_2 and chronic pulmonary fibrosis. Some increase in bronchitis in children (two and three years old) also has been observed at concentrations below 0.3 parts per million (ppm).

1.2.5 Lead

Pb is a stable element that persists and accumulates both in the environment and in animals. Its principal effects in humans are on the blood-forming, nervous, and renal systems. Lead levels in the urban environment from mobile sources have decreased significantly as a result of the federally mandated switch to lead-free gasoline.

1.2.6 Sulfur Dioxide

SO_2 is a product of high-sulfur fuel combustion. The main sources of SO_2 are coal and oil used in power stations, industry, and domestic heating. Industrial chemical manufacturing is another source of SO_2. SO_2 is an irritant gas that attacks the throat and lungs. It can cause acute respiratory symptoms and diminished ventilator function in children. SO_2 also can yellow plant leaves and erode iron and steel.

1.3 Mobile Source Air Toxics

In addition to the criteria pollutants for which there are NAAQS, the USEPA also regulates air toxics. Toxic air pollutants are those pollutants known or suspected to cause cancer or other serious health effects. Most air toxics originate from human-made sources, including on-road mobile sources, non-road mobile sources (e.g., airplanes), area sources (e.g., dry cleaners), and stationary sources (e.g., factories or refineries).

Controlling air toxic emissions became a national priority with the passage of the CAAA of 1990, whereby Congress mandated that the USEPA regulate 188 air toxics, also known as hazardous air pollutants. The USEPA has assessed this expansive list in its latest rule on the Control of Hazardous Air Pollutants from Mobile Sources (USEPA 2007) and identified a group of 93 compounds emitted from mobile sources that are listed in its Integrated Risk Information System (USEPA 2014a). In addition, USEPA identified seven compounds with significant contributions from mobile sources that are among the national and regional-scale cancer risk drivers from its National Air Toxics Assessment (USEPA 1999). These are acrolein, benzene, 1,3-butadiene, diesel particulate matter plus diesel exhaust organic gases (diesel PM), formaldehyde, naphthalene, and polycyclic organic matter. Although the FHWA considers these the priority mobile source air toxics, the list is subject to change and could be adjusted in consideration of future USEPA rules.

The rule on the Control of Hazardous Air Pollutants from Mobile Sources described above requires controls that will dramatically decrease MSAT emissions through cleaner fuels and cleaner engines. According to a FHWA analysis using EPA's MOVES2010b model (USEPA 2013b), even if VMT increases by 102 percent as assumed from 2010 to 2050, a combined reduction of 83 percent in the total annual emissions for the priority MSAT is projected for the same period (FHWA 2012).

1.4 Attainment Status/Regional Air Quality Conformity

Section 107 of the 1977 CAAA requires that the USEPA publish a list of all geographic areas in compliance with the NAAQS, plus those not attaining the NAAQS. Areas not in NAAQS compliance are deemed non-attainment areas. Areas that have insufficient data to make a determination are deemed unclassified and are treated as being attainment areas until proven otherwise. Maintenance areas are areas that were previously designated as nonattainment for a particular pollutant but have since demonstrated compliance with the NAAQS for that pollutant. An area’s designation is based on the data collected by the state monitoring network on a pollutant-by-pollutant basis. The project is in Oklahoma County, which is currently classified as an attainment area for all criteria pollutants (USEPA, 2013c). As such, the study area is currently considered to meet the national primary and secondary NAAQS for all criteria pollutants. It is likely, however, that the Oklahoma City area may be reclassified as an O_3 nonattainment area in the next round of EPA designations, which could occur possibly next year or earlier. According to the Oklahoma Department of Environmental Quality (2009), if an area is classified as nonattainment, it is required to do the following:

- Perform a complete and accurate inventory of all precursors within two years of designation, and repeat every three years until attainment is reached
- Develop periodic conformity demonstrations (prove that new roads and bridges, or improvements to roads and bridges, do not exacerbate the O_3 problem)
- Require offsets at a rate of 1.1 to 1 (any new facility locating in the nonattainment area must offset its emissions by obtaining emission reductions in the nonattainment area at a rate of 110 percent)
- Attain the standard within three years (two, one-year extensions may be obtained)

1.5 Ambient Air Quality in the Study Area

Table 2 presents the monitored air quality data at five sites within Oklahoma County for the years 2010 to 2012.

Table 2. Ambient Air Quality Monitoring Data (2010-2012)

Pollutant and Standard			2501 East Memorial Road Oklahoma Christian University Site ID 401091037			8900 South Air Depot Site ID 401090042			2712 South Midwest Boulevard Site ID 401090041			NE 10th and Stonewall Site ID 401090033			NW 5th and Shartel Site ID 401090035		
			2010	*2011*	*2012*	*2010*	*2011*	*2012*	*2010*	*2011*	*2012*	*2010*	*2011*	*2012*	*2010*	*2011*	*2012*
Carbon Monoxide (CO) [ppm] *1 hour standard = 35 ppm* *8 hour standard = 9 ppm*	1-Hour	Maximum		1.3	1.3							1.9					
		2nd Maximum		1.3	1.2							1.6					
		# of Exceedences		0	0							0					
	8-Hour	Maximum		1.1	0.7							1.1					
		2nd Maximum		1.0	0.6							0.8					
		# of Exceedences		0	0							0					
Particulate Matter [ug/m^3] *PM_{10} 24 hour standard = 150 ug/m^3* *$PM_{2.5}$ 24 hour standard = 35 ug/m^3* *$PM_{2.5}$ annual standard = 12 ug/m^3*	PM_{10}	Maximum 24-Hour	44	47	77										60	77	125
		Second Maximum	41	45	73										39	62	43
		# of Exceedences	0	0	0										0	0	0
	$PM_{2.5}$	24-Hour 98th Percentile	18	23	19										19	22	19
		Mean Annual	8.9	9.7	9.4										9.5	10.2	9.8
		# of Exceedences	0	0	0										0	0	0
Ozone (O_3) [ppm] *8 hour standard = 0.075 ppm*	8-Hour	First Highest	0.088	0.088	0.089							0.079	0.086	0.088			
		Second Highest	0.085	0.085	0.087							0.078	0.085	0.082			
		Third Highest	0.084	0.085	0.084							0.076	0.083	0.081			
		Fourth Highest	0.082	0.084	0.081							0.076	0.082	0.079			
		# of Days Standard Exceeded	0	19	15							0	16	12			
Nitrogen Dioxide (NO_2) [ppb] *1 hour standard = 100 ppb*		1-Hour Maximum	42	48	55							58	66	127			
		1-Hour Second Maximum	42	41	45							57	66	80			
		98th Percentile	39	39	37							47	55	60			
		# of Days Standard Exceeded	0	0	0							0	0	1			
Sulfur Dioxide (SO_2) [ppm] *1 hour standard = 75 ppb*		1-Hour Maximum	9	6	6												
Lead (Pb) [ug/m^3] *calendar quarter = 0.15 ug/m^3*		1st Maximum	0.005	0.006	0.007		0.007	0.304	0.026	0.3005							
		2nd Maximum	0.004	0.004	0.006		0.004	0.089	0.005	0.005							
		3rd Maximum	0.004	0.004	0.006		0.003	0.07	0.004	0.004							
		4th Maximum	0.004	0.004	0.005		0.002	0.054	0.004	0.0004							

Source USEPA Office of Air Quality Planning and Standards (AIRData); accessed at http://www.epa.gov/airdata/ad_rep_mon.html
Notes: Blank cells = data not available; $\mu g/m^3$ = micrograms per cubic meter; PM = particulate matter; ppb = parts per billion; ppm = parts per million

2.0 Methodology

2.1 Regional Air Quality

A regional, or mesoscale, analysis of a project determines its overall impact on regional air quality levels. Although the project is expected to change local traffic patterns, it is not expected to affect regional VMT. As such, the Crosstown Boulevard is not expected to affect regional air quality levels.

2.2 Mobile Source Air Toxics

As per FHWA's *Interim Guidance Update on Air Toxic Analysis in NEPA* (FHWA 2012), projects are grouped into the following tier categories:

- Tier 1—No analysis for projects without potential for meaningful MSAT effects
- Tier 2—Qualitative analysis for projects with low potential MSAT effects
- Tier 3—Quantitative analysis to differentiate alternatives for projects with higher potential MSAT effects

Based on FHWA's recommended tiering approach, the Crosstown Boulevard Project falls within the Tier 1 approach (i.e., without potential for meaningful MSAT effects), as the project is not expected to have a meaningful impact on traffic volumes or vehicle mix.

2.3 Microscale CO Analysis

2.3.1 Screening Analysis

A screening evaluation was performed on 15 intersections for Alternatives A and B, 18 intersections for Alternative C, and 30 intersections for Alternative D. These intersections were identified in the study area as the most congested and most affected by the alternatives. The screening evaluation criteria recommended in USEPA's *Guideline for Modeling Carbon Monoxide from Roadway Intersections* (USEPA 1992) were used as the basis for this screening. Following these criteria, sites fail the screening evaluation if: (1) the study indicates the LOS would decrease to D or below as compared to Alternative A, or (2) if the delay and/or volume increase from the Alternative A to the Alternatives B, C, and D at an intersection with a LOS of D or below.

The LOS describes the quality of traffic operating conditions, ranging from A to F, and is measured as the duration of delay that a driver experiences at a given intersection. LOS A represents free-flow movement of traffic and minimal delays to motorists. LOS F generally indicates severely congested conditions with excessive delays to motorists. Intermediate grades of B, C, D, and E reflect incremental increases in congestion from lowest congestion to gridlock. For this project, Alternative A is the six-lane boulevard concept developed in the Final

Environmental Impact Statement/Record of Decision. As such, all alternatives were compared to Alternative A. In addition, for each alternative, the number of sites with a LOS of D or below was tallied and the total number of sites with a LOS of D or below was compared between the proposed alternatives.

2.3.2 Microscale CO Analysis

A microscale CO analysis was performed at the intersection of the Crosstown Boulevard and E.K. Gaylord Boulevard, which is the intersection with the highest traffic volumes. Furthermore, this intersection would operate at LOS F in 2040 under all alternatives for which data are available. As such, this intersection is considered to be representative of worst-case conditions.

The most recent version of the EPA mobile source emission factor model (MOVES2010b, USEPA 2013b) and the CAL3QHC (Version 2.0) air quality dispersion model (USEPA 2006) were used to estimate 2015 and 2040 CO levels for all four alternatives.

Mobile source models are the basic analytical tools used to estimate CO concentrations expected under given traffic, roadway geometry, and meteorological conditions. The mathematical expressions and formulations that comprise the various models attempt to describe an extremely complex physical phenomenon as closely as possible. The dispersion modeling program used in this project for estimating pollutant concentrations near roadway intersections is the CAL3QHC (Version 2.0) dispersion model developed by EPA and first released in 1992.

CAL3QHC is a Gaussian model recommended in the USEPA's *Guideline for Modeling Carbon Monoxide from Roadway Intersections* (EPA 1992). Gaussian models assume that the dispersion of pollutants downwind of a pollution source follow a normal distribution from the center of the pollution source.

Different emission rates occur when vehicles are stopped (i.e., idling), accelerating, decelerating, and moving at different average speeds. CAL3QHC simplifies these different emission rates into two components:

- Emissions when vehicles are stopped (i.e., idling) during the red phase of a signalized intersection
- Emissions when vehicles are in motion during the green phase of a signalized intersection
-

The CAL3QHC (Version 2.0) air quality dispersion model has undergone extensive testing by USEPA and has been found to provide reliable estimates of inert (i.e., nonreactive) pollutant concentrations resulting from motor vehicle emissions. A complete description of the model is provided in the *User's Guide to CAL3QHC (Version 2.0): A Modeling Methodology for Predicting Pollutant Concentrations near Roadway Intersections* (Revised) (USEPA 1995).

The transport and concentration of pollutants emitted from motor vehicles are influenced by three principal meteorological factors: wind direction, wind speed, and the atmosphere's profile. The values for these parameters were selected, in accordance with USEPA's guidance, to maximize pollutant concentrations at each prediction site. That is, to establish a conservative, reasonable worst-case scenario. The following values were used for these parameters:

- Wind Direction—Maximum CO concentrations normally are found when the wind is assumed to blow parallel to a roadway adjacent to the receptor location. At complex intersections, it is difficult to predict which wind angle will result in maximum concentrations. Therefore, the approximate wind angle that would result in maximum pollutant concentrations at each receptor location was used in the analysis. All wind angles from 0 to 360 degrees (in 5-degree increments) were considered.
- Wind Speed—The CO concentrations are greatest at low wind speeds. A conservative wind speed of 1 meter per second (2.2 miles per hour) was used to predict CO concentrations during peak traffic periods.
- Profile of the Atmosphere—A "mixing" height (the height in the atmosphere to which pollutants rise) of 1,000 meters, and neutral atmospheric stability (stability class D) conditions were used to estimate microscale CO concentrations.

The CO levels estimated by the model are the maximum concentrations that could be expected to occur at each air quality receptor site analyzed given the assumed simultaneous occurrence of a number of worst-case conditions: peak-hour traffic conditions, conservative vehicular operating conditions, low wind speed, low atmospheric temperature, neutral atmospheric conditions, and maximizing wind direction.

Microscale modeling is used to predict CO concentrations resulting from emissions from motor vehicles using roadways immediately adjacent to the locations where predictions are being made. A CO background level must be added to this value to account for CO entering the area from other sources upwind of the receptors. Background levels for this analysis were obtained from the Oklahoma Christian University (2501 East Memorial Road) and NE 10^{th} and Stonewall monitoring sites. The background values used for the 1-hour and 8-hour CO levels, 1.6 ppm and 1.0 ppm, respectively, are the maximum of the second-highest levels from the past three years of data (2010–2012) at these locations. These values were conservatively used as the background for all CO modeling analyses. Future CO background levels are expected to be lower than existing levels because of mandated emission source reductions.

Traffic data for the air quality analysis were derived from traffic counts and other information developed for the *Crosstown Boulevard Traffic Operational Analysis* (Traffic Engineering Consultants 2014).

Emission factors were developed using the latest version of the USEPA's MOVES program, MOVES2010b (USEPA 2013b). MOVES2010b is the USEPA's state-of-the-art tool for estimating emissions from highway vehicles. The model is based on analyses of millions of emission test results and considerable advances in the USEPA's understanding of vehicle emissions. Compared to previous tools, MOVES2010b incorporates the latest emissions data, more sophisticated calculation algorithms, increased user flexibility, new software design, and substantial new capabilities.

3.0 Results

3.1 Regional Air Quality

Although the project is expected to change local traffic patterns, it is not anticipated to affect regional VMT. As such, the Crosstown Boulevard is not anticipated to affect regional air quality levels.

3.2 Mobile Source Air Toxics

Based on FHWA's recommended tiering approach, the Crosstown Boulevard Project falls within the Tier 1 approach (i.e., without potential for meaningful MSAT effects), as the project is not expected to have a meaningful impact on traffic volumes or vehicle mix.

3.3 Microscale CO Analysis

3.3.1 Screening Analysis

Table 3 presents the LOS and delay for the AM peak hour (the highest one-hour traffic period between 7:00 and 9:00 AM) and PM peak hour (the highest one-hour traffic period between 4:00 and 6:00 PM) at intersections in the study area for the alternatives for the years 2015 and 2040. These intersections represented the total number of intersections predicted to be affected by at least one of the project alternatives.

Based on the information presented in Table 3, five intersections in the AM peak hour and four intersections in the PM peak hour are predicted to experience LOS D or below for Alternative A in 2015.

For Alternative B, five intersections in the AM peak hour and seven intersections in the PM peak hour are predicted to experience LOS D or below in 2015. Alternative B is predicted to improve LOS and/or delay at one intersection in the AM peak period and two intersections in the PM peak period, as compared to Alternative A in 2015. Alternative B is predicted to worsen LOS and/or delay at four intersections in the AM peak period and five intersections in the PM peak period, as compared to Alternative A in 2015.

For Alternative C, nine intersections in the AM peak hour and eight intersections in the PM peak hour are predicted to experience LOS D or below in 2015. Alternative C is predicted to improve LOS and/or delay at two intersections in the AM peak period and two intersections in the PM peak period, as compared to Alternative A in 2015. Alternative C is predicted to worsen LOS and/or delay at six intersections in the AM peak period and five intersections in the PM peak period, as compared to Alternative A in 2015.

Table 3. Intersection Screening for CO Analysis

Intersection	2015 - Alternative A				2040 - Alternative A				2015 - Alternative B				2040 - Alternative B				2015 - Alternative C				2040 - Alternative C				2015 - Alternative D				2040 - Alternative D			
	AM		PM		AM		PM		AM		PM		AM		PM		AM		PM		AM		PM		AM		PM		AM		PM	
	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Boulevard/Klein	2.6	A	11.7	B	4.8	A	72.7	F	2.6	A	11.7	B	4.8	A	72.7	F	2.6	A	11.7	B	4.8	A	72.7	F	1.3	A	1.4	A	2.2	A	2.6	A
California/Western	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	27	C	23.5	C	143.8	F	170.6	F
California/Classen	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	40.7	D	28.9	C	222.6	F	140.2	F
California/Shartel	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	F	NA	F	NA	F	NA	F
California/Lee	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	34.4	D	27.2	D	NA	F	NA	F
California/Dewey	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	17.1	C	34.4	D	1272.1	F	1215.5	F
California/Walker	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	127.5	F	606.2	F	409.6	F	NA	F
Boulevard/Walker	29.8	C	41.6	D	47.5	D	322	F	28.8	C	57.6	E	122.3	F	213.3	F	20.1	C	34.6	C	64.7	E	125.6	F	NA	NA	NA	NA	NA	NA	NA	NA
Boulevard/Hudson	37.1	D	29.1	D	85.1	F	65.9	E	55	E	50.7	D	184	F	154.4	F	43.3	D	46.3	D	123.4	F	79.0	E	NA	NA	NA	NA	NA	NA	NA	NA
Boulevard/Robinson	38.3	D	33.2	NA	67.8	E	43.7	D	54.3	D	44.2	D	232.8	F	177.4	F	43.0	D	39.7	D	113.9	F	115.6	F	NA	NA	NA	NA	NA	NA	NA	NA
Boulevard/Broadway	0	A	0	C	0	A	0	A	.1	A	0	A	0	A	0	A	0.1	A	0	A	0	A	0	A	NA	NA	NA	NA	NA	NA	NA	NA
Boulevard/Gaylord	46.3	D	33.9	C	186.6	F	140.8	F	61.5	E	55.2	E	217.5	F	186.3	F	62.6	E	100.1	F	222.2	F	265.6	F	NA	NA	NA	NA	NA	NA	NA	NA
Boulevard/Oklahoma	4.1	A	6.1	A	4.8	A	6.5	A	4.8	A	5.7	A	7.2	A	9.7	A	4.8	A	5.7	A	7.2	A	9.7	A	NA	NA	NA	NA	NA	NA	NA	NA
Reno/Klein	24.8	C	25.4	C	29.2	C	61.6	E	23.1	C	23.3	C	35.4	D	77.4	E	21.0	C	23.4	C	22.2	C	22.8	C	20.5	C	17	B	22.1	C	20.5	C
Reno/Western	57.7	E	33.4	C	179.7	F	79.1	E	57.9	E	35.6	D	203.5	F	60.5	E	49.4	D	36.7	D	206.1	F	63.8	E	26.2	C	28.4	E	27.1	C	56.6	E
Sheriden/Classen	17.6	B	19.8	B	27.7	C	34.6	C	9.2	B	10.1	B	19.7	B	29	C	9.4	A	10.1	B	21.4	C	29	C	33.9	C	18.6	B	38.1	D	30.1	C
Sheriden/Western	33.7	C	25.1	C	34	C	16.3	B	16.6	B	24.3	C	21.4	C	18.8	B	16.6	B	24.3	C	15.9	B	25.2	C	22.5	C	16.9	B	20.5	C	22	C
Boulevard/Shartel	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	*	F	*	F	*	F	*	F	NA	NA	NA	NA	NA	NA	NA	NA
Boulevard/Reno	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	26.5	C	27.5	C	34.2	C	32.8	C	NA	NA	NA	NA	NA	NA	NA	NA
Boulevard/Lee	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	*	F	*	F	*	F	*	F	NA	NA	NA	NA	NA	NA	NA	NA
Reno/Walker	43.7	D	68.7	E	224.7	F	203.2	F	37.1	D	51.5	D	220.4	F	198.1	F	33.6	C	70.2	E	189	F	281.8	F	45.9	D	142	F	219.4	F	469.5	F
Reno/Hudson	28.2	C	18.1	B	186.5	F	88.4	F	33.8	C	27.4	C	164.5	F	75.4	E	39.6	D	34.6	C	146	F	153.7	F	51.1	D	35.4	D	79.9	E	62.9	E
Reno/Robinson	29.3	C	18.8	B	85.1	F	26.7	C	32.2	C	32.2	C	50.3	D	37.5	D	29	D	33.5	C	56	E	49.7	D	43.1	D	31.9	C	121.4	F	49.1	D
Reno/Gaylord	25.8	C	56.3	F	97	F	163.3	F	44.2	C	44.2	D	50.3	D	171.3	F	35.2	D	78.2	E	110.1	F	243.5	F	37.9	D	25.8	C	113.6	F	43.2	D
Reno/Shartel	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	22.8	C	16.1	B	99.3	F	74	E
Reno/Lee	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	21.6	C	14	B	16.7	B	17.1	B
Reno/Dewey	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3.8	A	7.7	A	13.4	B	63.4	F
SW 2nd/Shartel	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	7.9	A	7.6	A	NA	F	NA	F

Intersection	2015 - Alternative A				2040 - Alternative A				2015 - Alternative B				2040 - Alternative B				2015 - Alternative C				2040 - Alternative C				2015 - Alternative D				2040 - Alternative D			
	AM		PM		AM		PM		AM		PM		AM		PM		AM		PM		AM		PM		AM		PM		AM		PM	
	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
SW 2nd/Lee	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	6.4	A	6.3	A	8.5	A	8.3	A
SW 2nd/Dewey	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3.1	A	2.9	A	3.3	A	3.1	A
SW 2nd/Walker	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5.3	A	4.4	A	92.7	F	NA	F
SW 2nd/Hudson	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	4.7	A	3.6	A	5.1	A	6.4	A
SW 3rd/Shartel	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	24.6	C	22.3	C	111.5	F	127	F
SW 3rd/Lee	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	16.6	C	16.4	C	994.9	F	70.4	F
SW 3rd/Hudson	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	59.6	E	20.9	C	427.8	F	120.6	F
SW 3rd/Robinson	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	62.1	E	91.3	F	332.7	F	313.5	F
SW 3rd/Broadway	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.5	A	0.4	A	1.6	A	2	A
SW 3rd/Boulevard/ Gaylord	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	100.4	F	101.1	F	274.9	F	361.3	F
SW 3rd/Boulevard/ Oklahoma	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5.4	A	6.1	A	7	A	9.1	A
Total Sites with LOS D or below	5		4		9		10		5		7		10		11		9		8		11		12		11		9		19		20	
Total sites with LOS D or below and worse than Alternative A LOS or level of delay	NA		NA		NA		NA		4		5		6		6		6		5		6		7		4		3		3		2	
Total sites with LOS D or below and better than Alternative A LOS or delay	NA		NA		NA		NA		1		2		4		4		2		2		3		3		1		1		3		5	

* Delay on N/S approaches is so excessive that Synchro indicates an error in delay calculations.
Source: Traffic Engineering Consultants, February 2014
Notes: AM = morning; CO = carbon monoxide; LOS = level of service; NA= not applicable for this alternative; PM = evening

For Alternative D, 11 intersections in the AM peak hour and nine intersections in the PM peak hour are predicted to experience LOS D or below. Alternative D is predicted to improve LOS and/or delay at one intersection in both the AM and PM peak periods in 2015. Alternative D is predicted to worsen LOS and/or delay at four intersections in the AM peak period and three intersections in the PM peak period, as compared to Alternative A in 2015.

Based on the information presented in Table 3, nine intersections in the AM peak hour and 10 intersections in the PM peak hour are predicted to experience LOS D or below for Alternative A in 2040.

For Alternative B, 10 intersections in the AM peak hour and 11 intersections in the PM peak hour are predicted to experience LOS D or below in 2040. Alternative B is predicted to improve LOS and/or delay at four intersections and worsen LOS and/or delay at six intersections in both the AM and PM peak periods, as compared to Alternative A.

For Alternative C, 11 intersections in the AM peak hour and 12 intersections in the PM peak hour are predicted to experience LOS D or below in 2040. Alternative C is predicted to improve LOS and/or delay at three intersections in both the AM and PM peak periods, as compared to Alternative A. Alternative C is predicted to worsen LOS and/or delay at six intersections in the AM peak period and seven intersections in the PM peak period, as compared to Alternative A in 2040.

For Alternative D, 19 intersections in the AM peak hour and 20 intersections in the PM peak hour are predicted to experience LOS D or below in 2040. Alternative D is predicted to improve LOS and/or delay at three intersections in the AM peak period and five intersections in the PM peak period, as compared to Alternative A. Alternative D is predicted to worsen LOS and/or delay at three intersections in the AM peak period and two intersections in the PM peak period, as compared to Alternative A in 2040.

The intersections used in the above comparisons all experience a LOS of D or below in at least one alternative. In 2015 and 2040, Alternative D is predicted to have the highest number of intersections operating at a LOS of D or below, as compared to the other alternatives. Alternative A is predicted to have the least number of intersections operating at a LOS of D or below.

Table 4 presents the LOS and delay for the AM and PM peak hour at I-40 ramp intersections in the study area for the years 2013, 2015, and 2040. According to the table, LOS is predicted to be the same in 2013 and 2015 at all ramp intersections. LOS would worsen at two ramp intersections from 2013 to 2040 in the AM peak hour and at three ramp intersections from 2013 to 2040 in the PM peak hour. The ramp intersection of Western and I-40 (both eastbound and westbound) is the ramp intersection with the worst LOS, as it operates at LOS F in all years analyzed. Intersections/ramp locations that experience a LOS of D or below have the potential for elevated local pollutant emissions of CO.

Table 4. Ramp Intersection Screening for CO Analysis

Intersection	2013				2015				2040			
	AM		PM		AM		PM		AM		PM	
	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Western/I-40 WB Ramps	235.8	F	292.5	F	157.5	F	316.9	F	307.3	F	643.1	F
Western /I-40 EB Ramps	162.9	F	635.3	F	176.1	F	663.5	F	359.4	F	NA	F
Shields/I-40 WB On-Ramp	1.8	A	20.4	C	2.4	A	21.5	C	2.4	A	146.2	F
Shields/ I-40 EB Off-Ramp	19.9	B	15.2	B	14	B	17.3	B	92.8	F	51.4	D
Shields /I-40 EB On-Ramp	8	A	33.4	C	8.2	A	22.6	C	11.6	B	62.8	E
Robinson/ I-40 WB Off-Ramp	10.1	B	7.2	A	10	B	7.2	A	11.4	B	7.4	A

Source: Traffic Engineering Consultants, 2014
Notes: AM = morning; CO = carbon monoxide; EB = eastbound; LOS = level of service; NA= not applicable; PM = evening; ppm = parts per million; WB = westbound

3.3.2 Microscale CO Analysis

Maximum one-hour and eight-hour CO levels were predicted for the years 2015 and 2040 at the intersection of the Crosstown Boulevard (for each alternative) and E.K. Gaylord Boulevard. Maximum one-hour CO concentrations are shown in Table 5. Maximum eight-hour CO concentrations are shown in Table 6 . The CO levels estimated by the model are the maximum concentrations that could be expected to occur at each air quality receptor site analyzed. This assumes simultaneous occurrence of a number of worst-case conditions: peak-hour traffic conditions, conservative vehicular operating conditions, low wind speed, low atmospheric temperature, neutral atmospheric conditions, and maximizing wind direction.

Table 5. Predicted Worst-Case One-Hour CO Concentrations at the Crosstown Boulevard and E.K. Gaylord Boulevard (ppm)

Alternative	2015		2040	
	AM	PM	AM	PM
Alternative A	3.3	3.3	2.5	2.3
Alternative B	3.5	3.0	2.5	2.3
Alternative C	3.2	3.1	2.4	2.5
Alternative D	2.7	2.8	2.3	2.3

Notes: Concentrations = modeled results + 1-hour CO background. 1-hour CO background = 1.6 ppm; 1-hour CO standard = 35 ppm. AM = morning; PM = evening; ppm = parts per million

Table 6. Predicted Worst-Case Eight-Hour CO Concentrations at the Crosstown Boulevard and E.K. Gaylord Boulevard (ppm)

Alternative	2015	2040
Alternative A	2.2	1.6
Alternative B	2.3	1.6
Alternative C	2.1	1.6
Alternative D	1.8	1.5

Notes: Concentrations = (modeled results x persistence factor [0.7]) + 8-hour CO background. 8-hour CO background = 1.0 ppm; 8-hour CO standard = 9 ppm. CO = carbon monoxide; ppm = parts per million

Based on the eight-hour values presented in Table 6, 2015 CO levels at the intersection of the Crosstown Boulevard and E.K. Gaylord Boulevard are predicted to be slighter lower under Alternatives C and D and slightly higher under Alternative B, as compared Alternative A. In 2040, CO levels are predicted to be the same under Alternatives B and C and slightly lower under Alternative D, as compared to Alternative A. No violations of the NAAQS are predicted for any of the future analysis years.

In summary, a microscale CO analysis was conducted to determine if the alternatives have the potential to cause or exacerbate a violation of the applicable CO standards. The result of this analysis, which was conducted following the USEPA's *Guideline for Modeling Carbon Monoxide from Roadway Intersections* (USEPA 1992), is that the alternatives are not predicted to cause or exacerbate a violation of the NAAQS for CO.

3.4 Summary of Impacts

Since the Crosstown Boulevard is not expected to affect regional VMT, the project is not expected to affect regional criteria pollutant burdens or MSAT burdens. The project could, however, affect local levels of CO near those intersections with poor LOS. According to the screening analysis, Alternative A would have the least number of intersections with poor LOS and would therefore have less potential for elevated CO levels. Alternative D would have the most number of intersections with poor LOS and would therefore have the greatest potential for elevated CO levels of all the alternatives screened. Alternative C has the most intersections with degraded LOS and/or delay, as compared to Alternative A. The ramp intersection of Western and I-40 (both eastbound and westbound) is the ramp intersection with the worst LOS and would therefore have the greatest potential for elevated CO levels of all the ramp locations screened. Based on the results of the microscale CO analysis of the highest volume intersection affected by the project, the project alternatives are not predicted to cause or exacerbate a violation of the NAAQS for CO.

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